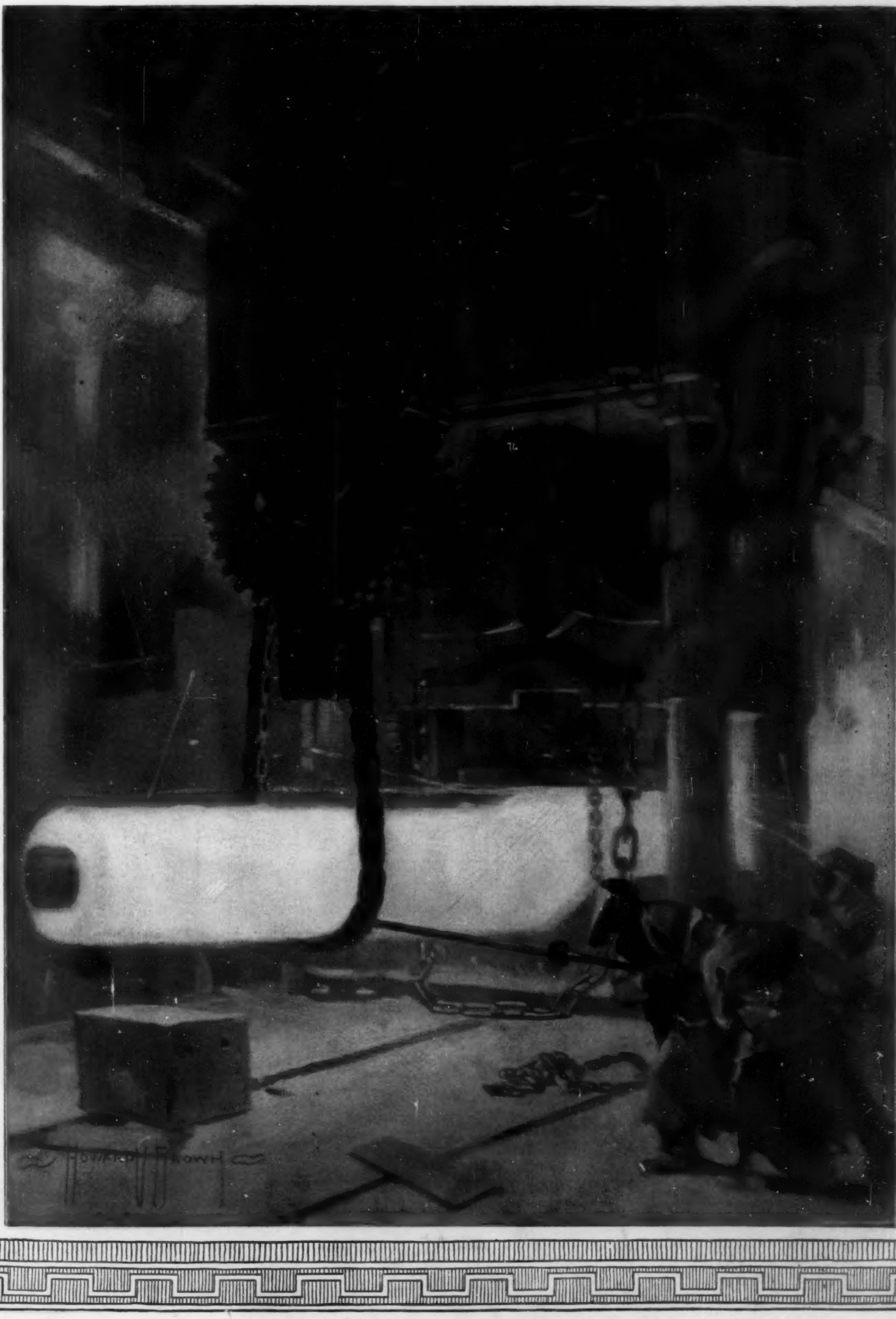
SCIENTIFIC AMERICAN



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Glacier Park Transportation Company	20
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Gulf Refining Company	186
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Kaufmann Brothers	44
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New York Board of Fire Underwriters	18
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Frank Parmelee Company	18
City of Pittsburgh	15
The Rosenbaum Company	34
Schulze Baking Company	21
W. & J. Sloane	19
Standard Oil Company of California	25
Standard Oil Company of Indiana	126
Standard Oil Company of New York	127
Standard Oil Company of Ohio	18
Stern Brothers	19
Supreme Baking Company	23
Union Oil Company of California	22
United States Government Post Office Department	109
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SEVENTY-SECOND YEAR

SCIENTIFIC AMERICAN

THE WEEKLY JOURNAL OF PRACTICAL INFORMATION

VOLUME CXIV.] NUMBER 6]

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Members of the Naval Militia on target range for annual qualification practice

Naval Militia and Preparedness

Discussing the Work and Aims of This Organization

By Lieut. W. J. Willis, N. M. N. Y.

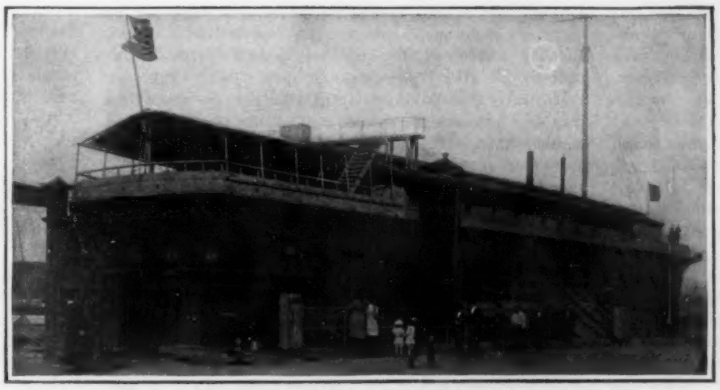
DURING the present nation-wide agitation about preparedness and means toward that end, there is an existing and very important basis upon which to build, in the form of the Naval Militia of the various states.

The consensus of opinion is apparently against the maintenance of a large standing army and possibly against the maintenance of the Navy at full war strength. Each of the courses suggested for adequate preparedness lays stress upon the necessity for the inauguration of an adequate first-line-of-relief for the standing Army and Navy. The National Guard is intended to serve this very purpose to the Army, and the Naval Militia bears the same relation to the Navy.

While the Naval Militia constitutes a part of the National Guard organization of the separate states, its instruction and training are under the direction of the Bureau of Naval Militia Affairs of the Navy Department. This training is designed to prepare the separate units of the Naval Militia for absorption into the regular navy, when necessary, with the least confusion possible. In other words, the Naval Militia must be trained in the discipline, practices and usages which experience has demonstrated as tending toward highest efficiency.

The operation of a modern man-of-war requires all of the diversified trades and professions represented in the operation of any large manufacturing plant, aside from trained gun-pointers and sight-setters. If the gun-pointer is to be allowed to use his skill against an enemy, he must be placed within range and kept within range. This necessitates an efficient engine-room and deck force. An engine-room force consists not merely of throttle-men and firemen, but also of machinists, electricians, water-tenders, oilers, blacksmiths, pipefitters, tinsmiths, and others down through all of the trades. The efficient direction of these various pursuits requires the presence of trained electrical and mechanical engineers. The care and preservation of the health of the men require the presence of doctors, pharmacists, and male nurses. That the men may be properly fed, cooks, mess-attendants, and an efficient commissary department are necessary. In like manner, the keeping of records and the issuance of orders require a force of stenographers and clerks.

The layman will immediately think that these various tradesmen may be mustered-in practically at a moment's notice. True, but any shop superintendent or works manager will tell you that, if these men were to be placed aboard ship to perform their various duties without any previous training in naval practices, pandemonium would result.



U. S. S. "Granite State," used as headquarters by the 1st Battalion, N. M. N. Y.

The keel of the "Granite State" was laid down in 1813, under the name of "Alabama," which was later changed to "New Hampshire" and finally to its present one. In her day this vessel was an 82-gun frigate.

Naval Militia gun crew at 3-pounder qualification target practice

If a ship is to be operated efficiently, all friction between the various departments must be prevented; and this end is attained by having one supreme head to each ship. Unquestioning obedience to the orders emanating from this head, therefore, becomes absolutely essential. The American citizen is probably less amenable to this sort of obedience than any other race in the world. It accordingly falls to the lot of the Naval Militia to teach discipline first.

While the Naval Militia, and more especially the engineering department, offers an opportunity to artificers of all branches to increase their value to their country—there are always sufficient untrained hands and minds to fill the ranks of the more pronounced military branches—by the practice of their different trades and professions, it is the aim of this branch of the National Guard to increase this value by courses of instruction and by lectures along the lines of each specific trade. Needless to state, this instruction is bound to increase the economic value of the men in civil life.

Inasmuch as service in the National Guard or Naval Militia is strictly voluntary, an enlistment must presuppose the presence of some patriotism. There are physical disabilities which disqualify the enlistment of many men, but even those physically disqualified may demonstrate their patriotism by doing all in their power to foster the same spirit in others. Patriotism does not mean the willingness to die for one's country only, but also the willingness and the desire to be of the greatest value to one's country in any branch or department. A good teamster is of more value to the commissary department far in the rear than he would be as a poor shot in the first-line trenches. A good cook is more valuable in feeding the crew well than he would be as a slow shellman serving one of the large guns.

In the case of the enlistment of an ordinary young American into the Navy, he must be trained not only into a Navy-man, but also into an artificer of some branch before his full value is realized. The Naval Militia offers an opportunity to the mature American trained in any craft to make himself a fully qualified Navy-man subject, who can be called in case of need by giving him instruction in the relation between his particular trade and the efficient operation of a man-of-war.

Although the Naval Militia, in order to fulfill its functions, must be a military organization primarily, it is made as attractive as possible in ways other than those of offering instruction in various trades and pursuits. Each unit combines a social organization with the military. This social organization is in-

(Concluded on page 164.)

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The object of this journal is to record accurately and lucidly the latest scientific, mechanical and industrial news of the day. As a weekly journal, it is in a position to announce interesting developments before they are published elsewhere.

The Editor is glad to have submitted to him timely articles suitable for these columns, especially when such articles are accompanied by photographs.

Preparedness and the Naval Militia

IN another portion of this issue appears an article which shows the relation of the Naval Militia to national preparedness.

American citizenship carries with it responsibilities as well as privileges. The privileges are many and varied. The responsibilities are fewer, but just as well defined. The franchise is both a privilege and a responsibility. We are sorry to say that we are of the opinion that the average citizen exercises the right of franchise as a privilege only. When an American citizen takes the oath of allegiance or casts his first vote he must assume the responsibilities of citizenship as well as the privileges. A person, unless he is unworthy of recognition as a citizen, must be actuated by patriotism when he takes the oath of allegiance or casts his first vote. The final attitude to be assumed by Congress toward preparedness is one of the responsibilities to be assumed by the American voter.

Each man is apparently content to let the other fellow assume all responsibilities. Just at present the country at large is sitting back and waiting to see what Congress is going to do about it. What *can* Congress do except vote an appropriation? This is the first step only. The next step is up to the private citizen individually. A big navy, authorized by Congress, is of no value if inadequately manned. A large standing army would be a useless sacrifice without a "first-line-of-relief." If a large navy is authorized by Congress there must be means at hand for rounding out the crews to full war strength at a moment's notice and for filling the vacancies caused by casualties. These vacancies may not be filled with green inexperienced men without sacrificing the efficiency of the entire body. Consequently a Naval Reserve is imperative. Is the American citizen going to refuse to assume this responsibility attendant upon his citizenship, and thus make compulsory service imperative? We certainly hope not.

Patriotism! That word is defined as "love of country." Truly it represents the life of a nation. When patriotism dies national honor and integrity go with it. A nation can no more stand without honor and integrity than can an individual or a corporation.

The patriotism of the individual is best demonstrated by his willingness and desire to serve his country in the capacity for which he is best fitted whether it is as mess-cook or teamster, admiral or general. The physically disqualified may be able to merely encourage others, but it is patriotism nevertheless. The employer should encourage patriotism among his employees, not because it represents insurance against war losses, but because it is his duty as a citizen. The Congressman may demonstrate his patriotism by dealing with the current questions of national honor and integrity and of national preparedness with his own political well-being sunk well into the background.

At the present date the Naval Militia of the United States consists of 523 officers and 5,846 men. If all of the various units were perfectly balanced and efficiently trained, this would be sufficient to man about eight of the larger ships in case of stress. As a reserve, it therefore amounts to the proverbial "drop in the bucket," but as a nucleus about which to build it represents the most wonderful opportunity for the trained American to demonstrate his patriotism to the fullest. The opportunity is there for the trained engineer, the professional man, as well. The rank and file must be officered, while still the militia, for drill and instruction purposes, and upon going aboard ship there must be officers to assume the responsibility for the operation of the engine-room and auxiliary machinery.

The employer, whether large or small, can express his approval of the National Guard organization in a variety of ways. One of the largest department stores in the country not only grants leave-of-absence with pay to all employees absent on military duty, but has founded and equipped an entire machine-gun company. A New England company grants not leave-of-absence with pay, but leave-of-absence with double pay to its employees away on duty. Most of the large corporations in the East now grant leave-of-absence with pay to all employees away on ordered military duty with no loss of vacation time.

If each American citizen does his duty according to his station in life, national preparedness will become a question of the past and a well-established, world-wide known fact of the present and future.

Shall We Abolish the Fahrenheit Thermometer?

REPRESENTATIVE ALBERT JOHNSON, of Washington, has sent to all members of the American Association for the Advancement of Science copies of a speech which he delivered in the House of Representatives last December in behalf of his bill, introduced at the present session of Congress, to discontinue the use of the Fahrenheit thermometer scale in Government publications. Together with this document he sends a circular, in which he solicits the advice and coöperation of the members of the association in connection with his project. The circular indicates that he entertains no doubt as to the desirability of abolishing the Fahrenheit scale, but is openminded as to the way in which this reform should be effected, in order to produce a minimum of inconvenience. The bill, as introduced, provides for a transition period, terminating January 1st, 1920, during which the branches of the Government may gradually adjust themselves to the use of the centigrade scale, and permits, during the same period, the use of Fahrenheit equivalents of centigrade degrees in parentheses, or otherwise, as may seem desirable.

Annexed to Mr. Johnson's bill are extracts from a number of opinions of the project which he obtained, before introducing the bill, from scientific societies and individuals. Most of these are favorable. He has now adopted the commendable plan of enlisting the aid of the American Association in a more thorough canvass of public opinion, and a committee of the association has taken this matter in hand.

It is superfluous to point out that a proposal to eliminate the Fahrenheit scale from all Government publications is one which ought to be most carefully considered before an irrevocable decision is taken. As matters now stand, the Government uses both scales; the centigrade, in connection with metric measurements, in most of its scientific work; the Fahrenheit, in connection with English measurements, in its industrial and business relations. The proposed change would, perhaps, not affect, to a very serious extent, any scientific branch of the Government except the Weather Bureau, which now makes comparatively little use of the centigrade scale, because the results of its activities are addressed, for the most part, to a public familiar only with Fahrenheit. It would be no easy task to educate that public to think of "zero weather" as meaning just freezing, or of "ninety in the shade" as a temperature that no human being could survive. Moreover, the temperature indications furnished by the Weather Bureau find immediate practical application in many important industries, all of which, if the proposed measure should become law, would be obliged to make constant and vexatious use of conversion tables, or follow the Government's example and abandon the old scale for their own purposes.

Before considering what would be gained by substituting the centigrade scale for the Fahrenheit it is worth while to point out that neither of these scales is an ideal one, nor, if our ancestors had taken the precaution of consulting us in regard to them, would either one have ever been adopted. In comparison with a scale reckoned from absolute zero, both are arbitrary and illogical. In point of utility, the Fahrenheit scale has some points of marked advantage over its rival. Although the German instrument-maker's naïve expedient of fixing his zero at the lowest point reached by the thermometer in a certain Iceland winter has not had the desired result of eliminating negative values of temperature from meteorological records, it is undeniable that such values are far more frequent in records kept in centigrade than in those kept in Fahrenheit. Moreover, as the centigrade degree is nearly twice as great an interval as the Fahrenheit, records kept in the latter realize a proportionately higher accuracy, when carried to the same number of decimal places. In order to make centigrade values as accurate as Fahrenheit we must add a column of figures—often entailing a very serious increase in the amount of printing.

Of course, the one strong argument in favor of adopting the centigrade scale for all purposes is that we should thereby secure uniformity, not only with other countries (Great Britain excepted), but between popular and scientific practice in our own country. This appears to be a very desirable object, when one considers the immense amount of labor that is now spent in the interconversion of scales, and one well worth the temporary inconvenience and expense that it would entail. But when we look more carefully into Mr. Johnson's plan, we find that the kind of international uniformity he proposes to attain is seriously qualified by the fact that he does not propose to adopt the metric system. He says:

"The metric system and the centigrade scale are two totally different subjects, and the attempt to yoke them together would merely create confusion. The essential advantage of the metric system lies in this, that it enables multiplication and division to be performed by the mere moving of the decimal point. This has nothing to do with the centigrade scale, because there is no occasion to multiply and very little occasion to divide degrees of temperature. Conversely, the essential advantage of the centigrade scale lies not in the division of the thermometric base into 100 deg., but in placing the zero at freezing point. This evidently has nothing to do with the metric system."

Just why is it more convenient to call the freezing point of water zero than to call it 32 degrees? Mr. Johnson has shown above that it is, for some purposes, decidedly less convenient, because leading to the more frequent use of negative quantities.

It is idle to speak of an "attempt" to yoke together metric and centigrade, because they are already yoked together in nearly the whole body of modern scientific literature. Tables and formulas of all kinds are expressed in centigrade-metric units, and these are, to a considerable extent, duplicated by tables and formulas in Fahrenheit-English units. In other words, centigrade degrees of temperature are always used in conjunction with meters, grams, etc.; Fahrenheit degrees with feet, pounds, etc.

The National Advisory Committee for Aeronautics

A SHINING exception to Great Britain's failure, before the present war began, to enlist the services of her men of science in behalf of military preparedness was the appointment, in the year 1909, of an Advisory Committee for Aeronautics, the function of which was to give scientific advice to the aeronautical branches of the army and the navy. Under the presidency of Lord Rayleigh and the chairmanship of Dr. Glazebrook, this body has given a world-wide impetus to the study of scientific aeronautics.

In the year 1913 a somewhat analogous body was formed in the United States, in connection with the reopening of the Langley Aerodynamical Laboratory of the Smithsonian Institution. This organization was not, however, especially concerned with military aeronautics. The Advisory Committee of the Langley Laboratory included members designated by the Secretaries of War, the Navy, Commerce, and Agriculture, but also many persons appointed directly by the Smithsonian Institution. Ultimately the committee found itself involved in a legal tangle arising from the fact that the coöperation of Government officials in its work had not been authorized by Congress.

As a remedy for this situation there was inserted in the Naval Appropriation Act approved March 3rd, 1915, a provision for a National Advisory Committee for Aeronautics. The promoters of this undertaking frankly acknowledged the source of their inspiration by incorporating in the bill a description of the proposed committee that is taken *verbatim* from the initial report of its British prototype. Thus the report of the British Advisory Committee for Aeronautics for 1909-10 (page 5) declares the work of the committee to be "the scientific study of the problems of flight, with a view to their practical solution," and adds that "the committee are to determine the problems which the experimental branch should attack, and to discuss their solutions and their application to practical questions," while the bill, drafted in 1915, organizing the American committee states that "It shall be the duty of the Advisory Committee for Aeronautics to supervise and direct the scientific study of the problems of flight, with a view to their practical solution and to determine the problems which should be experimentally attacked, and to discuss their solution and their application to practical questions."

The act above mentioned authorizes the President to appoint not to exceed twelve members, consisting of two from the aeronautical branch of the army, two from that of the navy, one each from the Smithsonian Institution, the Weather Bureau and the Bureau of Standards, and "not more than five additional persons who shall be acquainted with the needs of aeronautical science, either civil or military, or skilled in aeronautical engineering or its allied sciences."

Nominally, the American committee has a broader and more humanitarian field of activity before it than the British. One of its rules, approved by the President last summer, states that it "shall exercise its functions for the military and civil departments of the Government of the United States, and also for any individual, firm, association, or corporation within the United States; provided, however, that such department, individual, firm, association, or corporation shall defray the actual cost involved."

Notes on the War

Italian Navy and Austrian Submarines.—It is reported that the Italian navy is actively engaged at the present time in running down the submarines of the Central Powers that have been preying on Allied commerce in the Mediterranean. The methods employed by the British in the North Sea are being followed by the Italians.

Americans in the U. S. Navy.—It is learned from Government statistics that the United States Navy constitutes the most thoroughly American body of men in the world. Of the 52,561 men aboard American warships or serving on shore, 47,664 were born within the continental limits of the United States, and of the remainder 1,900 were born in the overseas possessions of this country.

Gaining Gun Power by Length.—The "California," "Mississippi" and "Idaho" are to be armed with a new type of 14-inch gun, which will show a considerable increase of power over the 45-calibre gun. The new piece is six feet longer in the bore than the 45-calibre 14-inch, and its velocity and energy have been greatly increased, the muzzle energy being something over 70,000-foot tons. Rear-Admiral Strauss, Chief of Ordnance, states that these new guns are capable of penetrating the heaviest side armor at oblique impact at the greatest effective battle range. It is gratifying to learn that the new type of 16-inch, 45-calibre gun, built at the Washington Gun Factory, has fulfilled the highest expectations, and that the Bureau believes it to be as powerful a gun as any in existence to-day.

U. S. Navy and Other Navies.—According to a report recently submitted to the House Naval Committee by Josephus Daniels, Secretary of the Navy, the ranking of the leading naval powers, based on such information as is now available, is as follows: Great Britain, Germany, United States, France, Japan, Russia, Italy, Austria, Spain, Argentina, and Brazil, representing a total of 137 dreadnoughts laid down prior to August 1st, 1914, and 25 dreadnoughts laid down or authorized since then. Since many of the belligerents are known to be building warships in secret, the last number is, in all probability, considerably greater. Dreadnoughts are now said to cost on an average $15,000,000 each, while some cost $12,000,000. Those now being built by the United States will cost in the neighborhood of $18,000,000.

The Zeppelin as an Offensive Weapon.—Basing its calculation upon the data which was procured when the Z-4 made a descent at Luneville, France, in 1913, "Aeronautics" estimates that the maximum capacity of the modern Zeppelin for carrying high explosives is about one and one half tons, and that they cannot possibly carry the five tons which have been claimed for these ships of the air. The same authority estimates that in crossing the 300 miles from the German base to the English coast, a ton and a half of fuel is consumed and that if a ton and a half of explosive is carried a static state of equilibrium will have been attained by the time the coast is reached, the lifting power thereafter being dependent upon the lifting planes. Explosive bombs carried by the Zeppelin weigh 185 pounds and the incendiary bombs about 20 pounds each.

An Offset to the "Audacious".— If the circumstantial dispatch from Rotterdam stating that one of Germany's newest dreadnoughts recently ran on a mine in the Baltic and sank be correct, the loss of this ship will fairly offset the loss of the British dreadnought "Audacious" off the Northwest coast of Ireland. The latest German dreadnoughts are those of the "Koenig" class, all of which are probably by this time in commission. The names of the vessels are "Kronprinz," "Grosser Kurfurst," "Koenig" and "Markgraf." In displacement, they are about the same as our "Wyoming," though in armament they are inferior, carrying ten 45-calibre 12-inch guns against the "Wyoming" twelve 50-calibre 12-inch; but they are better protected, having a 14-inch belt against the Wyoming's belt of 11 inches.

Armenian Civilization.—Travelers have recognized for centuries, says Sir Edwin Pears, that the Armenian population of Turkey, numbering about two millions, is a most valuable element in the country. The people, like ourselves, belong to the Indo-European race. A large portion of them occupy a mountainous country, and the men are usually stalwart and industrious. Their country was civilized and prosperous in the time of Christ, and I cannot doubt that the general average intelligence of Armenians is due to the fact that they are the descendants of parents who have been civilized for centuries. Armenia was the first country to establish Christianity as the religion of the state. Their great Christian teacher and national saint is Gregory the Illuminator. . . . It is rare to visit the house of an Armenian in a fairly prosperous condition where there is not evidence of artistic and musical taste: pictures or a piano, or other musical instruments.

Astronomy

The New Draper Catalogue.—At the meeting of the American Astronomical Society last August, Miss Annie J. Cannon reported that the classification of spectra for the new Draper Catalogue was completed except for a small portion of the sky, and that the work would probably be entirely finished and ready for the printer in October. On July 27th, 1915, the total number of spectra classified was 221,601, of which about 180,000 had been identified and entered in the card catalogue.

Legislation for the Preservation of Meteorites.—The *South African Journal of Science* records the steps that have been thus far taken, at the suggestion of the South African Association for the Advancement of Science, to secure legislation in various countries relative to the preservation of meteorites in the interests of science. The committees of Sections A and C of the British Association adopted the following resolution at the Australia meeting: "That in view of the fact that meteorites which convey information of world-wide importance are sometimes disposed of privately in such a way as to deprive the public of this information, the council be requested to take such steps as may initiate international legislation on the matter." Since the Australian meeting this resolution has been accepted by the council of the British Association and transmitted to the International Association of Academies.

Photographs of the Zodiacal Light, gegenschein, and other large faint objects have been made by Prof. A. E. Douglass, who described his method as follows at the California meeting of the American Astronomical Society: Absolute freedom from city lights is essential. He uses a lens of large aperture and short focus, making a small picture; also a panorama mechanism with a curved film and a sort of focal plane diaphragm passing a curved opening across the front of the film. Multiple exposures, simultaneously or in immediate succession are made on the faint object up to any number desired. These are all developed; then they are placed one above the other in careful registration and prints made from this compound negative. If necessary a similar compound positive is made, from which a final negative with any desired contrasts is obtained.

The Last Number of the Memoirs of the Lowell Observatory announces a discovery in connection with Saturn. This investigation, by Director Lowell, is concerned with the theoretic and observed positions of the recently discovered as well as the old divisions of the ring-system. All of these divisions are caused by the perturbing action of Mimas on the particles of the rings. In consequence of their not quite agreeing with the theoretic positions, an investigation was entered into which has succeeded in throwing new light on the internal condition and distribution of the matter composing Saturn's ball. The observed positions of these divisions can seemingly only be reconciled by a greater internal oblateness than has hitherto been supposed, which demands a greater speed in the kernel than the husk. Not the least interesting fact about this result is that measures on the rings should lead to a discovery about Saturn's internal constitution.

The Photoelectric Photometer.—Messrs. Jacob Kunz and Joel Stebbins reported at the last meeting of the American Astronomical Society that various improvements have been made during the past year in the methods of preparing photoelectric cells in the laboratory, and their photoelectric photometer has been completely reconstructed. The effective sensibility of the instrument has thus been increased five- or six-fold. A year ago it was about equal in sensibility to the selenium photometer and could be used, with a 12-inch telescope, for stars down to the third magnitude, but it can now be used in observations on stars of the fifth magnitude. The accuracy attainable with this instrument depends upon the brightness and position of the stars to be observed, but the authors claim that a probable error of ± 0.005 magnitude may be easily obtained for stars of about magnitude 3.5.

Lady Huggins's Gift to Wellesley.—Although the late Lady Huggins, the wife and collaborator of the famous English spectroscopist and astronomer, was never in any way connected with Wellesley College, she took a keen interest in this institution, as an example of the intellectual opportunities for women afforded by the New World. This interest has been manifested in a striking way, for it appears that, in accordance with the terms of Lady Huggins's will, the American institution has become the owner of a large collection of her most personal belongings. These objects, which were recently placed on exhibition at Wellesley, include more than 700 books, besides pictures, furniture, artistic and historic jewelry, bric-a-brac, etc., and, of special interest, 12 small astronomical instruments, including the smallest spectroscope ever made—a wedding gift to Lady Huggins—and a spectroscope which belonged to the chemist Miller, who worked with Mr. Huggins when he first began to investigate the chemistry of the stars.

Radio Communication

Pope to Bless Wireless.—According to a report from the Rome correspondent of a prominent news service, Vatican circles announce that the Pope is preparing to bless wireless telegraphy officially, thus restoring the ancient custom of the Church to bless inventions which confer great benefits on humanity.

Portable Army Pack Set.—The Signal Corps of the United States Army is building a high power field wireless set with a sending radius of 250 miles. It can be knocked down and shipped in packages weighing 350 pounds, maximum. Furthermore, states the *Army and Navy Journal*, its parts are specially convenient for shipment, and can be carried by pack trains.

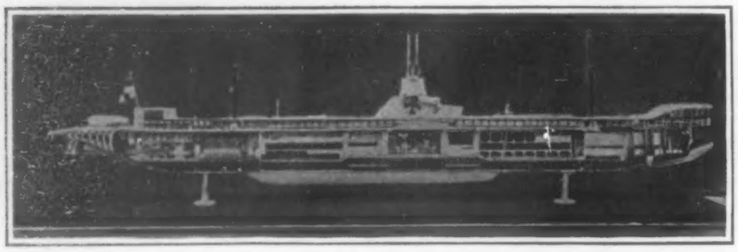
Proposed Government Radio Monopoly.—The last annual report of Captain W. H. G. Bullard, superintendent of the Navy Radio Service, contains a recommendation that the Government control and operate all coastal radio stations within the jurisdiction of the United States, in such manner establishing a practical monopoly for the transmission of all Government business. For some time there has existed considerable friction between the naval radio men and the wireless amateurs, and often the threat has been heard of late that the Navy is soon to control all wireless communication in this country.

Three New Stations for U. S. Navy.—With the approval of the contract between the Navy and an American wireless company for the equipment of the radio stations at San Diego, Cal.; Cavite, P. I., and Pearl Harbor, Hawaii, one of the final steps has been taken toward linking the United States with its overseas possessions. Not only will radio communication be possible between Washington and the insular possessions, but it will also be possible to send dispatches to almost any point in the world. The stations under construction at Pearl Harbor and Cavite will be the most powerful in the world; the continuous range of these stations being in excess of 4,700 miles.

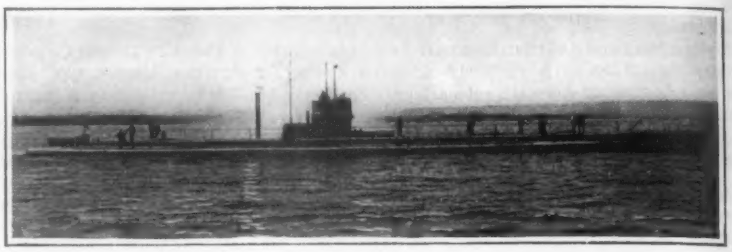
Wireless Communication Between United States and Japan.—The Japanese government recently notified the Marconi Wireless Telegraph Company that the new station at Funabashi, near Tokio, was completed and would be ready for trans-Pacific communication at an early date. Experiments that have been going on between that station and Honolulu are reported to be most successful, and no difficulty is being experienced in maintaining communication over the 3,400 miles that intervene. In some instances the Japanese station has been heard at San Francisco, a distance of 5,600 miles. The Funabashi station is rated at 300 kw. Were it not for the fact that Japan is engaged in war, the station would probably be in active service to-day.

Radio Station for the Society Islands.—According to an announcement made by the United States Bureau of Navigation, it is learned that a powerful radio station has been built on Tahiti, one of the Society Island group, by the French government. The temporary station is of 10 kw. capacity, and will be used until the permanent station is completed. The latter will have an aerial system supported by eight towers, each 325 feet high, placed in two parallel rows of four towers each. Two antennae will be provided for two different wavelengths. It is expected that the permanent installation will be capable of working with Sydney, South America, Honolulu, San Francisco, Cochin-China, and even Martinique and Guadeloupe. On January 5th the temporary station on Tahati was heard at San Francisco.

Commercial Extra First-Grade Licenses.—The United States Department of Commerce is now issuing a special license, known as commercial extra first-grade, to radio operators, whose trustworthiness and efficient service entitle them to confidence and recognition. These licenses are given consideration by the Civil Service Commission in examinations for positions requiring knowledge of radio telegraphy, when experience is rated as part of such examinations. Applicants for this grade of license must pass a special examination. To be eligible for this examination they must hold commercial first-grade licenses, and their certificates of skill in radio communication, issued under the act of June 24th, 1910, or licenses under the act of August 13th, 1912, must record 18 months' satisfactory commercial service at sea or at land stations, either or both, during the two years previous to the filing of the application for examination, as shown by indorsement on the license service records, or other satisfactory evidence, and provided that the applicants have not been penalized for a violation of the radio laws and regulations. A speed of at least 30 words per minute, Continental Morse, and 25 words per minute, American Morse (five words to the word), must be attained. The technical questions and the questions on the radio laws and regulations are considerably wider in scope than those for commercial first grade, and a higher percentage is required.



Cross section of a German submarine of an early type



German submarine of an early type entering a harbor

Submarine Warfare

Early History of Underwater Craft and Their Recent Uses in Naval Activities

ALTHOUGH much had been expected of the submarine, it cannot be denied that craft of this type have fully met, if not exceeded, expectations. On second reflection this statement stands amendment: it is perhaps more logical to state that in purely naval engagements, *i. e.*, in warfare against recognized armed vessels, the submarine has not accomplished what had been expected of it; but, on the other hand, its versatility in penetrating underwater barricades, in bombarding land works and troops, and in warfare on unarmed merchantmen, has been truly startling and, indeed, a revelation.

The submarine, although recognized as a later-day instrument of warfare, dates back much further than is generally believed. Leaving out of account the early attempts of a Dutch physicist in 1620, and those of the Englishman, Symons, in 1747, it may be a surprise to many Americans to learn that the first submarine attack was undertaken in the War of Independence in 1775. David Bushnell, an American patriot, constructed a crude vessel of wood, which was manually propelled. Behind the vessel was a magazine containing about 150 pounds of powder and a clock-work exploding device. In marked contrast to present-day practice, in which the submarine accomplishes its destructive errand by discharging a self-propelled mine or topedo against an enemy vessel, the magazine of Bushnell was attached to the hull of an undesirable ship by means of a cable terminating in a wood screw. It was thus kept in position until the explosion took place some time later. Bushnell carried out a submarine attack on the British warship "Eagle," and, although he succeeded in maneuvering his craft under the unsuspecting enemy, he failed properly to attach the mine or magazine to the bottom planking of the "Eagle," with the result that the explosion took place about an hour later at some distance away from the intended victim, and without causing any damage to the enemy.

Although Bushnell's attempt was not successful, it held much promise, and for that reason it was not lost sight of. Robert Fulton, who built the famous steamer "Clermont," offered Napoleon a submarine of his invention for the contemplated invasion of Great Britain, and a German engineer, Wilhelm Bauer, in 1850, came forth with plans for a submarine by which, to use the words of Burgoyne, an English writer on maritime subjects, "the solution of the problem of submarine navigation was promoted to a higher degree than any other inventor."

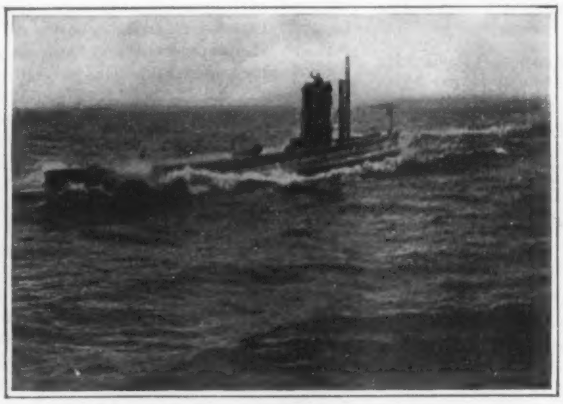
Wilhelm Bauer, constructor of the first German submarine, was born in 1822 at Dillingen, Bavaria. He took part in the German-Danish war during 1849 as an artillery man of the Schleswig-Holstein army. Thanks to financial help extended to him by the army and navy authorities, as well as by private persons, in 1850, at Kiel harbor, he was able to put into practice his ideas relating to the construction of a submarine. His craft was intended for use against the Danish warships then blocking German harbors; but it never made an attack on the enemy fleets. In connection with an experiment in Kiel harbor in 1851, the vessel foundered, but the crew was saved. Thirty-six years later, in 1887, the submarine was salvaged in connection with the construction of a torpedo harbor at Kiel, and at the present time the remains of Bauer's submarine rest in the courtyard of the Berlin Marine Museum.

In 1883, the Swedish engineer, Nordenfeldt, built a submarine boat at Stockholm, which might well be considered as the immediate forerunner of the underwater craft of the present day. This vessel had a length of 64 feet and a displacement of about 60 tons; the propulsion being furnished by a steam engine of 100 horsepower. When running submerged, steam stored in large tanks, together with that in the boiler, served to drive the engine; the fire under the boiler being allowed to subside before submerging.

Since Nordenfeldt's submarine, the problem of underwater navigation has been given careful consideration by the leading naval powers. The French marine authorities are recognized as having been the first to undertake methodical tests intended to promote the development of the submarine boat. Other naval powers followed suit, rather slowly at first, but more energetically later, with the result that the underwater craft was rapidly developed from an experimental craft to a practical weapon of attack. Among the last to take up submarine construction was Germany. According to German naval men, there was no harm in maintaining a wise reserve while other nations were spending time and money in costly experiments. Thus it was that the German navy began to concern itself with the submarine as a naval weapon as late as 1905, and it must be admitted that the present war has proved the excellence of their underwater craft as well as the skill of their crews.

A modern submarine boat, to be really effective, should be especially sea-worthy not only in the sense of surface navigation, but also in being able to withstand tremendous water pressure encountered when submerged even a slight distance below the surface. The problem of propulsion is one of the most important. In practically all modern submarines, gasoline or oil engines are used when on the surface, while electric motors and accumulators are depended upon for submerged navigation. A speed of 10 or 11 knots is ample for submerged navigation, but, while traveling on the surface, speeds of 18 to 20 knots are attained by the latest German submarines. The radius of action, without replenishing the oil tanks, is as high as 5,000 to 7,000 in the most recent models.

View through the periscope of a German submarine



German submarine traveling on the surface at full speed

The torpedo is to the submarine boat what the projectile is to the gun. It is accordingly essential that each craft must carry a sufficient supply of torpedoes to be effective against enemy ships. Each of the latest type of German submarines is ordinarily supplied with 10 or 12 torpedoes, which may be discharged through six torpedo tubes—four ahead and two astern—thus permitting of their discharge in quick succession if necessary.

The diving power of the submarine is, of course, of the highest importance. Sufficient water having been admitted into tanks to cause the boat to submerge until only the conning tower protrudes above the surface, the horizontal rudders are manipulated to overcome the last traces of buoyancy, whereupon the craft plunges to any depth, within certain limits, that may be necessary. In order to again rise to the surface, the water is driven out by compressed air and the horizontal rudders manipulated.

Four German submarines or U-boats with their mother ship in a seaport

When running entirely submerged, a submarine is practically blind; that is to say, the pilot cannot see because of the darkness of the surrounding water, and is accordingly obliged to lay his course entirely by compass and chart. However, when running partially submerged, or even at a depth of a few feet, it is possible to obtain a view above water through the agency of an optical device known as a periscope, consisting of a tube carrying at the upper end a system of mirror prisms, which reflect the image of the horizon through the tube to the lower prisms and then into the interior of the submarine. Thus it is possible for the

pilot and crew to obtain a view of the entire horizon, with the craft entirely hidden below the water, barring the single exception of one or two periscopes measuring but a few inches in diameter.

Service on board a submarine is extremely trying. In fact, it places a perpetual strain on the mental capacity of the crew because of the complexity of the manifold apparatus and machinery, gages, periscopes, compasses, delicate instruments and other devices. Even a slight mistake is at times liable to result in the death of the entire crew. Aside from the mental strain, the lack of exercise and the poor air are but two of the conditions which try the strongest constitutions.

Aside from the remarkable exploits of British submarines in the Baltic Sea and in the Sea of Marmora, the Germans have proved to be the masters of underwater navigation in the present war. Although the Allied forces were slow to make use of their submarines in the earlier months of the great war because of the scarcity of enemy ships on the high seas, they have since become very active, not only in the Baltic, but also in the closed-in body of water, the Sea of Marmora, which has been reached by diving below netting and mines which the Turks placed across the western entrance to this waterway.

No more interesting account of the high degree of perfection attained in modern submarines, both in material and personnel, could perhaps be offered than the experiences of Naval Lieut. Wenninger, commander of the German submarine U-17 (which torpedoed the French steamer "Graveline"), during a recent raid in which his craft became caught in a net of an English boat off the coast of England. Here is the way in which he told the story to a representative of the American press:

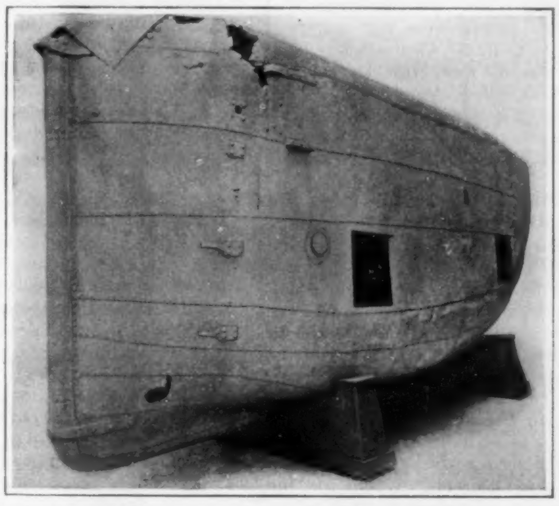
He said that they left their base early in the morning and passed into the North Sea, the boat being under water, with the periscope awash. "I looked through the periscope," he continued, "and could see a red buoy behind my boat. When, ten minutes later, I looked I saw the buoy again, still at the same distance behind us. I steered to the right and then to the left, but the buoy kept on following us. I descended deep into the water, but still saw the buoy floating on the surface above us. At last I discovered that we had caught the chain of the buoy and that we were dragging it along with us. At this time I also saw through the periscope that a strange, small steamer was steering a course directly behind us and the buoy. At the same time my sounding apparatus indicated that a screw steamer was in the vicinity. Observation revealed that five enemy torpedo-boats were approaching from the north. I increased the speed of the boat in the expectation of being able to attack one of them. The five torpedo-boats arranged themselves in a circle. I sank still deeper and got ready for eventualities.

"At this juncture my boat began to roll in a most incomprehensible manner. We began to rise and sink alternately, the steering gear being apparently out of order. Soon afterward, I discovered that we had encountered a wire netting and were hopelessly entangled in it. We had, in fact, got into the net of one of the hunters surrounding us.

"For an hour and a half the netting carried us with it, and, although I made every effort to get clear of it, it seemed impossible. There was nothing to do but to increase the weight in the submarine as much as possible so that I might try to break the netting. Fortunately, when we started I had pumped in from five to six tons of water, filling all the tanks. I increased the weight of the boat to the utmost, and suddenly we felt a shock and were clear of the netting. I then descended as deeply in the water as I could, the menometer showing 30 metres. We remained under water for 18 hours. When I wanted to ascertain where we were, I noticed that my compass was out of order. For a time I steered by the green color of the water, but at last I had to get rid of the ballast in order to rise. I then discovered that the menometer continued to register the same depth, and was also out of order. I had therefore to be very careful not to rise too high and thus attract the attention of the torpedo boats.

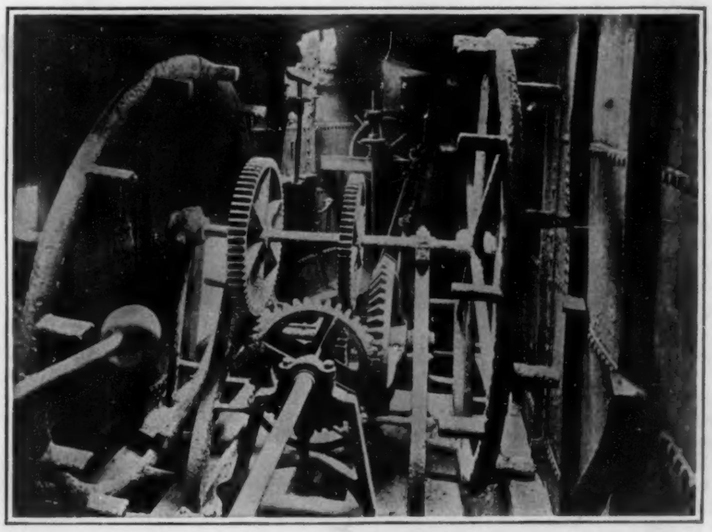
"Slowly the periscope rose above the surface, and I could see the enemy in front of me, and toward the left the east coast of England. I tried to turn to starboard, but the rudder did not work. In consequence, I had to sink again to the bottom of the sea, where I remained for six hours, at the end of which time I had succeeded in putting the compass in order, and also in repairing the steering gear. But upon rising this time, we were detected by a torpedo-boat, which made straight for us, forcing me to descend again. I remained submerged for two hours, then turned slowly outward, and, a distance of some 50 metres from the leading enemy craft, passed toward the open sea. At nine o'clock in the evening we were able to rise to the surface in safety."

Thus has the submarine boat been perfected.



Exterior view of the first German submarine, now resting in the court yard of the Berlin Marine Museum

Wilhelm Bauer, constructor of the first German submarine boat



Interior view of the first German submarine, showing the pedals and gears by which foot power was applied for propulsion purposes

The Hottest Region in the World

BEFORE attempting to answer the question, "Which is the hottest region in the world?" it is necessary to define one's terms. Does this inquiry refer to the region having the highest average temperature throughout the year, or to that in which the highest temperatures occur at the hottest season? It so happens that the most remarkable extremes of heat are attained in regions having a rather wide range of temperature; *i.e.*, where it is not hot all the year around, and hence where the average temperature for the year is not abnormally high.

The question stated above is a common one, and probably in most cases the person who asks it has in mind a comparison of maximum rather than mean temperatures. Assuming the question to be asked from this point of view, the answer to it will no doubt surprise most American readers. So far as can be learned from observations made at regular meteorological stations, the hottest region in the world is not in the heart of Africa, or South America, or even in the torrid deserts of Asia—but in the United States of America

On the eastern edge of Death Valley, California, a certain borax company has laid out a ranch embracing some 100 acres of irrigated land, on which are grown alfalfa, fruit and vegetables. Although it has been stated on excellent authority that you cannot hold a fire in your hand by thinking on the frosty Caucasus, the owners of the above-mentioned property doubtless had an analogous expedient in view when they named their estate "Greenland Ranch."

In the spring of 1911 the Weather Bureau established a coöperative station at this place, and the results of the observations made here during the subsequent four years are discussed by Mr. G. H. Willson in the current number of the *Monthly Weather Review*. The thermometers are installed in a standard screen, placed over an alfalfa sod, about four feet from the ground. The shelter is not exposed to the reflected heat of the desert. The location is about 178 feet below sea level.

On July 10th, 1913, the maximum thermometer at Greenland Ranch registered 134° Fahr., the highest "shade" temperature ever recorded at a meteorological station anywhere in the world, and four degrees above the previous "record," observed at Mammoth Tank, also in California on August 17th, 1885. Outside of the United States the "record" for a regular meteorological station appears to be 127° Fahr., which occurred at Wargla, Algeria, on the edge of the Sahara Desert, August 27th, 1884.

During the hot spell in which this extraordinary temperature was measured at Greenland Ranch, the daily maxima were as follows: 8th, 128°; 9th, 129°; 10th, 134°; 11th, 129°; 12th, 130°; 13th, 131°; and 14th, 127°. Throughout this frightful hot wave the temperature never fell below 85° Fahr.

The records made at this station during the past four years show that temperatures reaching 100 or more have occurred on 548 days, and may be expected at any time from April to October, inclusive; the highest occurring in July or August. Temperatures of 120 or more have been recorded in May, June, July and August. In July and August the average daily maximum has always exceeded 110°, while in July, 1911, it was 117°. In July, 1914, the mean temperature for the month (*i. e.*, half the sum of the mean maximum and mean minimum) was 101.6°. Yet Mr. Willson tells us that in the lower valley bottom higher temperatures undoubtedly prevail than at the meteorological station!

Cold weather is not unknown at Greenland Ranch. Minimum temperatures of 32° (freezing) or below have been recorded in November, December, January and February. On January 8th, 1913, the temperature fell to 15° Fahr.

Heat and Magnetism

AT a recent meeting of the Société de Physique, Mr. Cotton read a paper upon the rapid disappearance of the magnetism of iron at a red heat and illustrated this action by an experiment in which the effect was readily seen. A long aluminum tube is arranged so as to swing freely from a pivot support at the top end, and means are provided to limit the swing by a stop piece. At the lower end of the tube is a curved platinum wire carrying a sheet iron plate at one end. The device is placed near the poles of a strong magnet so that the tube or pendulum swings towards the magnet owing to the attraction exerted on the iron plate, and the pendulum is thus drawn to the limit of its swing. The flame of a large Bunsen burner is placed so as to entirely surround the iron plate when in this position, and when the plate reaches a red heat it loses its magnetic properties and ceases to be attracted, so that the pendulum now falls down to the zero position. When the iron plate cools down, it resumes its magnetic properties and is again attracted by the magnet, so that the plate enters the flame and becomes heated, and so on. In this way the pendulum is made to keep up a constant swing. On this principle, the loss of magnetism by heat can be made the basis of a device which furnishes motive power, though in a small amount in the present case. This should not be considered as perpetual motion, however, since heat is required.

Industrial Preparedness for Peace

II. Making a Study of My Business

By Miner Chipman

The Scientific American's *campaign of Industrial Preparedness for Peace has for its purpose to awaken the nation to the urgency of immediate preparation for the competition we are sure to encounter when production takes the place of destruction in Europe. The campaign was launched with an article by Miner Chipman, in the issue of January 15th, on "The Meaning of National Efficiency." This is the second of Mr. Chipman's series. Following it, on the next page, is an article by George W. Perkins, on Germany's preparedness, not only for war, but for peace, as well. An illustration of our dependence on Germany, and what steps we are taking to liberate ourselves, will be found in Dr. Thos. H. Norton's article on "The Potash Famine," which appears on page 146.*—Editor.

I HAVE received a number of letters from business men relating to our campaign for Industrial Preparedness for Peace. There seems to be one question which bothers the manufacturer and merchant more than all others, and that is this: "How can I prepare when I do not know what I am preparing for?" In other words, how is the American business man going to be able to develop adequate plans of offense and defense, in a commercial sense, if he does not know the conditions under which he will be called into the fight for business supremacy? At first glance, this appears to be a very reasonable question, but in reality it is entirely beside the issue. If we knew just exactly what is going to happen, when it will happen, and how it will happen, there would be no need for any hue and cry for industrial preparedness. It has been a favorite saying of American business that we should never cross a bridge until we come to it. We haven't. At times we haven't crossed a bridge when we came to the point where a bridge ought to be. In many respects, American business ideals are like American legislative ideals, hindsight and not foresight. We are a great people for investigating. Unfortunately our investigations are usually *ex post facto*. If a factory burns and many lives are lost, if a ship sinks or turns turtle, if anything *unforeseen* happens—we must have an investigation. We are not going to cross any bridges before we come to them, but we are going to *know* that bridges *exist* at the points where we may urgently require them.

A little while since a man from a small middle-west town was telling me about the fire department in his home city. Following a very disastrous fire, the city fathers became suddenly progressive, and had a very modern and complete water-system introduced. A volunteer fire department was organized, and upon summer evenings the people of the town were entertained by the fire department's activities in "washing down" the dome of the county court-house. In a number of minor fires the new equipment proved to be effective. Time passed. No fire of any importance occurred. The fire department grew lax in practice and attendance to the monthly meeting in the council chamber. One night in the middle of February a fire broke out in the boiler room of the saw mill. The whistle blew, the volunteers gathered and dragged the hose-cart through the snow to the nearest hydrant. The unexpected happened. The hose burst. Long disuse, old age, decay, these things allowed the fire to spread with terrific rapidity. Half the town was destroyed. Preparedness gone to seed! A typical American habit.

There is a great deal of very indefinite talk about our problem of industrial preparedness. We have certain favorite topics of discussion. Since the beginning of the war in Europe we have heard a great deal about the aniline dye situation. In the press and upon the platform it is used as a powerful example of America's unpreparedness. Unfortunately, this situation is also *ex post facto*. The development of aniline dyes required intensive study, elaborate and patient laboratory research, and years and years of careful commercial development. Germany stands supreme in the aniline dye market because of her industrial preparedness 25 or 30 years ago. At the present time we can look upon the aniline dye situation in the same manner as we look backward upon the "Eastland" disaster, and make a vow that "it will not happen again." The real reason why Germany has a monopoly in the aniline dye market is not inherently commercial in nature. It is found away back in the national ideals of the German people. Technical education, and support and encouragement of technical research, these things were the fundamental causes of German advancement in the chemical trades. Mr. James Armstrong very vividly points out to us the national characteristics of the German in their policy of commercial preparedness in his paper appearing in the "British World's Work," reprinted in the Scientific American for the week of January 20th, 1916. The real problem of American Industrial Preparedness does not lie in the direction of those things which have been neglected so long. We must look toward new opportunities, we must strengthen our weakest places, and build anew upon the experiences and lessons drawn from the European war.

America leads the world in certain lines. We stand in the machine-tool trade as Germany stands in the aniline dye industry. We are world leaders in the manufacture of automobiles. American railroad practice is second to none. We have proven our ability to pioneer, survey and build into unknown fields. Industrial preparedness for peace, if it means anything at all, means an extension of that particular ability. We may look for slight gain in commercial supremacy by any advantages to be taken of the present conditions. We do not know what will happen after the war. A large number of men with whom I have been in correspondence believe our chief danger lies in the "dumping" of products into American markets. This may be true, but the object of this campaign for Industrial Preparedness for Peace lies much deeper than the immediate effects of a declaration of Peace. We are looking toward the long years of reconstruction and readjustment of world markets. Where will the United States stand at the show-down? That is the question that is bothering us.

American industry is altogether too complex and varied in its nature to permit us to deal with a particular and individual problem. It is our object to get the vast field of little business, that great body of business enterprise which forms the backbone of our commercial life, thinking and working in the direction of adequate industrial preparedness. The great corporation, with its limitless resources, has available for immediate use the laboratories, chemists, experts and specialists in all lines. This paper is written particularly for the business man whose volume of business, and financial resources, do not permit him to make elaborate and intensive studies of markets, efficiencies and business conditions. The outline is not intended as a scientific basis of economic investigation. It is merely a skeleton of thought, about which the average business man may build the foundation of his future policies.

The Industrial Editor of the Scientific American will be pleased to receive comments and suggestions relative to this Survey, and answer such questions as he will be able to answer. It is our desire to coöperate with American business in the development of a national Survey, and, within our limited means, will do our utmost to serve effectively.

If our business man will sit down for an evening with the following outline before him, and assign to different members of his organization particular subjects to report upon, and get his associates in business working with him upon the problem of industrial preparedness, we have made a very encouraging start. Answers to the questions must not be superficial. Each man must assure himself that he has exhausted his means of communication. He must dig down to the bottom, if possible. If he does not go to the bottom, he must know with a degree of certainty how far he has gone. If this preliminary survey accomplishes nothing more than a realization of the factors within the problem, we will be quite satisfied with the result.

The Survey

Every business may be divided into the following general factors:

1. Ideals and policies.
2. Personnel.
3. Plant and equipment.
4. Materials.
5. Processes.
6. Distribution.

This classification is empirical, and is not intended as a scientific analysis of business relations. I have divided the problem into these factors for purposes of discussing Industrial Preparedness for Peace.

Ideals and Policies

Back of every business we have the ideals of the individual or individuals who are operating the business. They are trying to do something. The term business is a general one, applied to the operation of putting these ideals into action. Upon the basis of these fundamental ideals a business man evolves certain policies of business conduct. From an efficiency point of view, it is essential that we analyze the ideals and policies of a business to determine whether or not they are properly co-ordinated, and are working themselves out in actual practice. The following questions will serve as a basis for such determination:

1. What am I in business for?
2. What is my business?
3. What have I to work with?
   (a) Capital.
   (b) Men.
   (c) Materials.
   (d) Customers.
4. What were my ideals when I started in business?
5. What were my policies?
6. How have they worked out?
7. What changes have taken place in ideals and policies?
8. Why the change?
9. Have I changed my ideals and policies in proper relation to the changing conditions of business?
10. Am I sure about it?
11. What are the present policies of my business? As to:
    (a) Capital.
    (b) Plant and equipment.
    (c) Human relations (organization).
    (d) Processes.
    (e) The sale of my product.

Personnel

The peanut man on the corner is distinctly an individualist. He and his peanuts constitute all there is to his business. He is the organization. In ever-widening circles, from the peanut man to the United States Steel Corporation, there are organizations of men and women directed by certain ideals and policies of commercial and industrial endeavor. The essentials of success to be found in the peanut man and the Steel Corporation are identical. The difference is one of numbers and not of nature. The wise peanut man figures out the best place for his cart. He goes there and establishes himself. He gets business and makes money. The United Cigar Stores Company did the same thing on a more elaborate scale. The problem of *Personnel* deals with the human relationships within a business. An organization is made up of people. A man or a woman in a business institution are parts of a great human machine. If we will examine our organization in the same manner as we would look into the mechanism of our typewriting machine, we will discover the necessity of knowing something definite about *Personnel*. A good typewriter is not constructed and sold upon the basis of *how many* parts there are in it. The purchaser of a typewriter is essentially interested in how well, and how efficiently, the writing machine performs the functions of a typewriter. Every part of the machine is designed for a particular purpose, and contributes toward the general efficiency of the whole. Our business man should have a very adequate grasp of the make-up, relationship, and functioning of his organization.

(1) What kind of an organization exists within my business?
(2) Can it be charted in definite form, showing functions and relationships?
(3) Is that organization properly co-ordinated with the process and procedure of my policy of doing business?
(4) How does my organization, in type, and in personal characteristics compare with that of my competitors?
(5) Is my organization the most effective form of organization?
(6) What other forms of organization are successfully operated?
(7) What are the advantages of my own type?
(8) What are the disadvantages?
(9) What changes are advisable?

Plant and Equipment

Every business must have plant and equipment. The peanut man may operate with a two-wheeled cart, and the railroad with its vast holdings of real-estate, terminals, and rolling stock. A business should have no more, and no less, plant and equipment than that required efficiently to carry out its policies of operation. Each and every item of capital invested should be placed for its most effective productiveness. There are efficiencies of *dollars* as well as efficiencies of *men*. An inlaid rosewood peanut cart would be an attractive thing upon the street corner, but its efficiency as a means to sell peanuts would be questionable. One of the most glaring inefficiencies of American industry is *over-equipment*. We are over-equipped in machines and men in many lines of our industrial activity. The economic effects of this over-equipment are tremendous. This inefficiency is measured in the terms of Dollars . . . dollar efficiency, and not in the units of production. One of the greatest errors in computing the *cost of production* is that of improperly distributing the wastes of inefficient investment. We figure costs upon the basis of *what is*, rather than upon the basis of *what ought to be*. As a result, we revolve in a vicious circle, and never know our potential possibilities for improvement. From the viewpoint of preparedness for peace, we should look into our plant and equipment in the following form:

(1) What have I invested in plant and equipment?
(2) Is it up-to-date?
(3) Under what disadvantages do I labor because of obsolescence?
(4) What is the most modern and efficient type of:
  (a) Building and layout for my business?
  (b) Machinery for my particular processes?
  (c) Tools, jigs, and fixtures for the operations involved?
(5) What is my present output?
  (a) Per machine?
  (b) Per department?
(6) What should my output be?

Actual output divided by what the output should be will give you a figure showing your relative efficiency.

(7) What would my possible output be with the most modern type of machinery and equipment?
  (a) With the same investment?
  (b) With an increased investment?
  (c) With a lessened investment?
(8) How do I stand in relation to my competitors?

Materials

Let us examine the problem of materials utilized in my business in the following manner:

(1) Make a list of all materials purchased.
(2) Make a comparative statement showing:
  (a) Amount in value, and per cent of total.
  (b) Amount in units of weight, or other unit of measurement, and per cent of total.
(3) Sources of these materials:
  (a) Point or origin.
  (b) From whom purchased.
  (c) Price range.
(4) Characteristics of materials:
  (a) Chemical standards.
  (b) Other standards.
(5) What materials are the most difficult to procure in the quantity and quality desired?
(6) Why?
(7) What remedies present themselves?

Processes

The best way to examine your business as a whole is by the aid of a Process Chart. This chart is made up of a sequential arrangement of materials, machines, and the human element in your business. In the experience of the writer, a process chart has been the most effective means of quickly discovering the important relationships between the factors of a business. Take your pencil and make a circle for each item of material that you use in the process of manufacture. Arrange these circles along the top of a large sheet of paper. Group the materials as they are related to each other in your process. Drop a line down from each item, and in a small circle indicate how, or in what form, this material is tested. In a series of circles indicate the points where these materials are worked, brought together, or any operation which brings about a change in their nature. Continue this grouping until you reach the point where the materials have been created into a finished product. No matter how complicated and varied your business may be, you will be able to draw a diagram in this manner, which will show you the general process of your business. If you have colored pencils, it will be helpful to indicate machines in one color, and men, women, or children in other colors. Different machines may be indicated by different signs or symbols. As you develop this chart, you can definitely place each and every item of plant and equipment. Every member of your organization can be shown upon this chart, and their responsibility shown in the terms of process and materials.

The making of a complete process chart is one of the finest efficiency tests for an organization. It is, at times, very remarkable how indefinite the idea of the process of business is to even the general manager of a large business. He has a certain grasp of the thing as a whole, but is totally unable to chart the process step by step without a great deal of revision, conference, and checking up. In a large paper mill, which had been operating for a great many years, it required several months to prepare an accurate process chart of its operation.

When you have completed this chart and checked it up from every angle, it will be wise to look a little further and discover how your process chart compares with the best practice in your particular line of business. Turn your process chart over to the chemist in your laboratory and let him render you a report upon it. Put it up to him to advise you as to possible economies and better methods of production. Turn a copy of it over to your mechanical department and request them to report to you in the same manner. Give as many men in your organization, as time and opportunity will permit, a chance to report upon it, for betterment and efficiency.

Distribution

The problem of distribution will be treated in a subsequent paper upon this subject. It is a problem equal in importance, and in many cases of greater importance, than that of production. It is best that we have a very thorough knowledge of our manufacturing processes and opportunities, and then make an adequate examination of how we may profitably dispose of our product.

Germany's Example in Preparedness

By George W. Perkins

IN considering the question of preparedness, the men of this country should be extremely careful not to allow themselves to think of it in one single groove, viz., in a military sense—that is, preparedness measured simply in terms of battleships, forts, soldiers, and munitions.

I believe that in our discussions of the day we are too apt to think of the word "preparedness" in the narrow sense of meaning war munitions only, whereas, as a matter of fact, "preparedness" means three things: preparedness in war munitions, preparedness in industrial equipment, and preparedness in leadership.

Take Germany as an illustration. Well-informed Americans know that Germany is equally prepared in war munitions, in industrial equipment, and in leadership. The real marvel in modern Germany is not her military organization or her war munitions, but her industrial organization and efficiency. For a quarter of a century she has been mobilizing her industrial resources, getting away from the old notion that competition is the life of trade, and moving forward to the newer belief that coöperation is the life of trade. This has enabled her to mobilize her industries, so that in times of peace they could be used to save the waste, improve the efficiency, and in every way better the condition of her domestic merchants, her export merchants, her agricultural and laboring classes. The result has been that Germany's laboring class has been better housed, better clothed, better fed in recent years than the working classes of many other countries. This has made her people loyal and patriotic and welded them into one united body, which feels that there is something in their country worth fighting for. Consequently, when this war broke out her industrial fabric was well-knit and easily mobilized and brought to the support of her military organization. With this in mind, it is easily understood how Germany has been able to send one great army far into Russia, another into France, another into Belgium, another to the Dardanelles, and clothe and provision them without a serious hitch anywhere.

In the matter of leadership Germany is equally well prepared. The best minds in Germany give a considerable percentage of their time to public service. They are not all just mere money-grabbers, bent on making every last cent they can out of anything and everything, to be used for their own personal, selfish satisfaction and enjoyment. The German men, having all in their youth received military training, learned early to think of their country and their government as something that belonged to them, something of which they were a part and to which they owed a duty. This is so ingrained in the German youth that he never gets it out of his system, and, therefore, when he reaches manhood it is quite natural for him to feel that he owes to his country a certain amount of service just for the sake of service.

This has given to Germany a leadership in business and in statesmanship that is unique among the civilized nations of the world. It has given that country the service, in a loyal, patriotic spirit, of the best minds of the country.

When we come in this country to the consideration of preparedness, as we now do, it behooves us to consider it in the same broad, all-around sense as Germany has, and I fear we are not considering it in any such way. In discussing preparedness nowadays, nearly all the talk one hears has to do with the number of battleships we should have, how much larger standing army we should have, whether our forts are up-to-date or obsolete, etc. This, of course, is all very well, but it is only all very well so far as it goes, and, in my judgment, it goes only one third of the way, for we have got to be as well-prepared industrially as we are in a military sense; and, above all, we have got to be prepared in leadership—leadership that will stand uncompromisingly for our institutions and our ideals; indeed, being prepared in leadership is the most important preparedness of all.

The war now on in Europe is bound to open up a great new world of thought and action. Old theories and old precedents are going to be consigned to the scrap heap. A reconstruction period in world-thought and action is before us. Improved inter-communication has wiped out State lines and National lines. The man with the airship will be no respecter of boundaries. The problems of one country will be the problems of all countries. To cope with this entirely new situation we must produce an entirely new type of statesmen—men capable of thinking and acting not within the limits of a precinct or a state, but in terms of the nation and the world. The day may come when we will need volunteers at arms—the day is already here when we need volunteers for public service—men who are willing to make a sacrifice, men who will enter public service as they enter military service, in an unselfish, patriotic spirit, prepared to forego something, to give something, actuated by a deep conviction that they owe a duty to the country of their birth or adoption. Only through such inspired leadership can our country occupy its proper place in the new world movement that is so rapidly unfolding.

"Strays" in Wireless Telegraphy

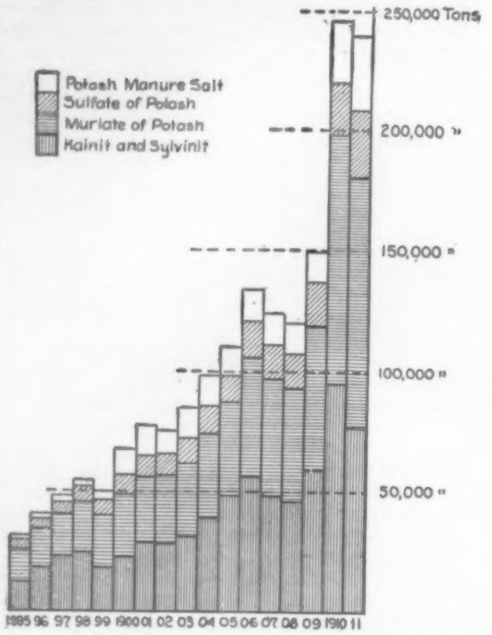
EVERY wireless operator is only too familiar with the erratic and troublesome noises in the telephone receiver of a wireless station, or the equally confusing marks on the tape of a coherer and inker set, due to natural electric waves, and variously referred to as "atmospherics," "static," "strays," "X's," etc. The nature of these phenomena is not yet fully understood, and they have, accordingly, been made the subject of extensive investigations by a committee of the British Association. The name of Dr. W. H. Eccles, who serves as secretary to the committee, has been especially identified with this field of research.

Shortly before the beginning of the European war the committee in question undertook to collect statistics on the occurrence of "strays" at wireless stations throughout the English-speaking world and in a few other countries. Although this programme was interrupted by the war, a certain amount of material was collected during the period from April to July, 1914, and some interesting results deduced therefrom were presented at the recent meeting of the British Association in Manchester.

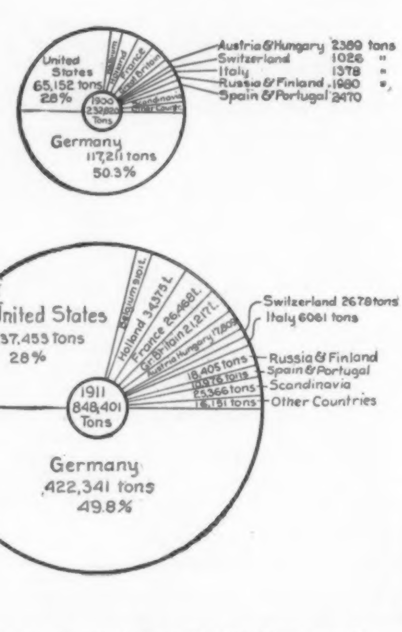
The principal and most generally reported fact is that the strays heard in the dark hours are much more numerous and louder than those heard during daylight. Curves have been drawn for various stations showing the amount of disturbance to radiotransmission from hour to hour, and these curves are found to be of two types; one in which the changes from day to night and night to day conditions are somewhat abrupt, and another in which they are more gradual. The lowest point of the curve usually falls a little after midday, and the highest a little after midnight, at stations north of the equator. The shape of the curve is greatly affected by local meteorological conditions.

Periods of excessively violent and frequent strays, rendering radiotelegraphic work almost or quite impossible, are called "X-storms." Periods of severe strays coincide with periods of low barometer, high wind velocity, rapid change in temperature, great rainfall, and especially rapid barometric fluctuations. In short, X-storms occur in connection with vigorous convective disturbances in the atmosphere, and the committee suggests that they may frequently be due to local weak electrical discharges accompanying such disturbances, and not necessarily to distant and more violent discharges—*i. e.*, lightning—as has been supposed.

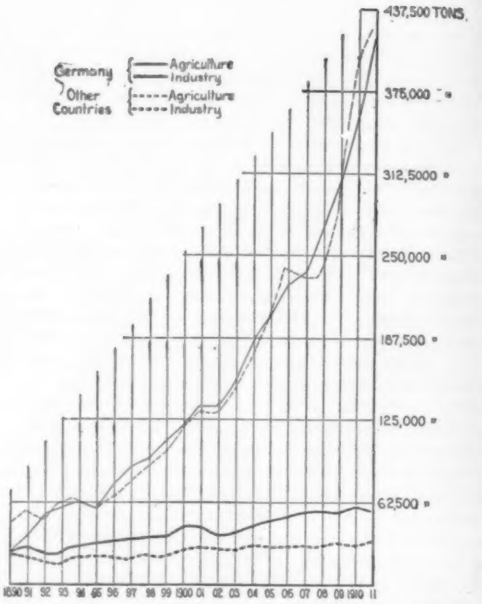
There is another type of X-storm, which occurs simultaneously at stations as much as 2,500 miles apart and is evidently not connected with local weather conditions. The committee has not yet investigated these storms, but Dr. Eccles and others have previously suggested that strays are frequently due to extraterrestrial causes, perhaps being related to disturbances in the sun.



Consumption of potash salts in the United States for agricultural purposes



Consumption of potash for agricultural purposes in different countries



Comparison of amounts of actual potash used in agriculture and the industries

The Potash Famine

Its Magnitude and Effects, and Remedies Promised for the Future

By Thomas H. Norton, Ph. D., Sc. D., Bureau of Foreign and Domestic Commerce, Washington

HOW many of us have come face to face with famine? Not many.

Some years ago I followed in the wake of an Asiatic army. Village after village of roofless, plundered homes, and empty granaries, separated by devastated fields and gardens. The men were exterminated. The terror stricken women and children would creep from their hiding places as I passed, fall at the feet of my horse, and beg for the fraction of a cent which might secure a meal.

The hollow eyes and gaunt frames alone presented an appeal for succor, never to be forgotten.

There are other famines besides those of human nutriment.

This country is experiencing for the first time in its history a dyestuff famine. Vast industrial interests, vitally dependent upon the factor of color, felt a condition of partial paralysis, as months pass by without the needed supplies. They suffer, exactly as a man would suffer, in whose diet the small, but all essential constituent of mineral salts is systematically and continuously reduced to a fraction of what the human body requires.

Such a famine threatens American agriculture at the present time. The plant life, to which millions of acres in our national domain are devoted, demands its customary supplies of food. Regular, well-balanced rations of albumen, fats, and carbohydrates, with small amounts of certain inorganic compounds are needed to maintain life in an animal organism. In a similar manner, the crops of our farms, and gardens, and orchards require well-defined rations of combined nitrogen, phosphoric acid, and potash, with slight amounts of various metallic compounds, in order to assure a normal, abundant harvest.

The phosphoric acid ration we supply easily from the inexhaustible deposits of phosphate rock and pebble in Florida, South Carolina, Tennessee, and some of the Western States.

For nitrogen our fields depend chiefly upon the sodium nitrate of Chile and upon ammonium sulphate from Great Britain, along with a small amount of cyanamid and a larger amount of animal refuse, guano, etc. Altogether, we send annually, under normal conditions, about $30,700,000 abroad for combined nitrogen—$17,700,000 going to Chile. The major portion of this Chile saltpeter is used, however, to produce the stock of nitric acid which we require in such abundance for a multitude of industries. A considerable amount of nitrogenous matter, for use as a fertilizer, comes from our slaughter houses, fish canneries, etc.

It is a matter of some concern that as a nation we are so dependent upon foreign sources for the greater portion of the nitrogen ration required in American agriculture, and for practically all of the nitric acid, indispensable in the manufacture of our high explosives.

In the case of potash the situation is much more serious. We practically depend upon a single source—the mines of Stassfurt in Germany—for the entire quantity of potash compounds, needed by American farmers, and required in the arts.

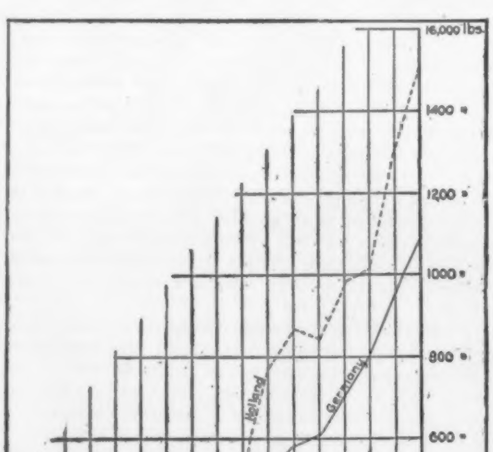
What such dependence means has been revealed to us during the past year. During the ten months ending October 31st, in 1913, we imported 811,000 short tons of potash compounds from Europe. During the same period in 1915, the imports were but 106,000.

What is the effect of this shrinkage in the normal supply of potash compounds?

Ordinarily our broad acres expect to be fed with over 1,000,000 tons of potash salts each year. They were on short rations last spring. There was none for the autumnal culture. There will be none next spring!

Our industries require annually over 23,000 tons of potash salts. The magnificent glass industry, with its annual output worth over $90,000,000, consumes each year about 3,500 short tons of potassium carbonate.

No supplies available for the glass blowers, nor for the manufacturers of gunpowder, nor for the soap boilers who specialize in soft soaps, nor for the makers of yellow prussiate, or bichromate, nor for match manufacturers, nor for scores of varied industries preparing therapeutic, and photographic, and similar products, in which potash is an absolutely essential component! The uses of the various salts of potassium, the chlorate, the bromide, the cyanide, the iodide, the permanganate, and numerous others, are encountered in a large group of industries. In all of these highly developed phases of human activity, the lack of potash compounds means as much of a dislocation as would the elimination of the butcher or baker from the life of a village. People would not necessarily die, but it would involve endless readjustments to unexpected conditions.



Relative consumption of actual potash in fertilizers in different countries

The hardest blow falls after all upon the farmers of our country. The effects will be felt most keenly in our Gulf and South Atlantic States, and in New England, where the use of potash fertilizers is highly developed.

The following table gives an interesting glimpse of the extent to which this item of plant food is consumed in different states. The figures represent the average number of pounds of pure potash (K_2O) employed per 100 acres of cultivated land:

	Pounds.
Florida	2,131
South Carolina	1,317
New Jersey	1,307
Massachusetts	966
Maine	900
North Carolina	837
Rhode Island	810
Georgia	764
Connecticut	757
Delaware	747
Maryland	690
Alabama	517
Virginia	426
New York	307
New Hampshire	288

It is astonishing to note how limited is the relative amount of potash consumed in the remaining states. Thus:

Illinois	12
Kansas	.48
Iowa	.22

I am tempted to wander from my main theme, and call attention to the fact that Germany, on an area, less than that of Texas, uses in her agriculture nearly twice as much potash as is consumed in the whole of the United States. Holland with an area equal to that of New Jersey and Connecticut, uses three times as much potash per acre, as these states, and a total amount equal to one seventh of our entire consumption.

Denmark is less than one quarter of the size of Illinois—a similar flat stretch of agricultural land. Yet it requires more than four times as much potash annually. Is it any wonder that the fields of those countries produce crops twice or thrice as large as the average yield of our own farms! American agriculture is still far from realizing how easily the harvests of its broad domain can be doubled, without an additional day of labor.

The question becomes acute with each passing day:

(*Concluded on page 162.*)

New Developments in Military Aeroplanes

Aeroplane Destroyer versus Battle Aeroplane

By Ladislas d'Orcy

METHODS of aerial warfare have once more reached a new stage of development.

Five months ago the writer examined in these columns* the radical changes which had occurred both in the *matériél* and in the fighting methods of the air services of the warring nations, after one year of warfare. Under-powered machines had been weeded out; the monoplane seemed a craft of the past; the mounting of a machine gun had become generalized on scouts and on bombing aeroplanes; finally, the general trend of design seemed to lead toward the adoption of a high-powered, large surfaced machine of great carrying power and heavy armament, which was termed a "battle-aeroplane."

This tendency was both noticeable in France and Germany, although the solution of the problem was carried out in ways fundamentally different.

The French conception was to provide an aeroplane with artillery superior in volume, but embodied into one gun; adequate armor protection and a fairly high speed. The result was the *avion-canon*, a 200-horse-power pusher biplane, which has a speed of about 80 miles per hour and mounts a 37 mill. quick-firing gun on the bow. The first flotilla of these aeroplanes was placed in commission last summer, and at once assigned to the defense of Paris. As soon as new flotillas came into being, they were sent to the bases behind the front and detached to escort the bombing squadrons on raids into enemy territory.

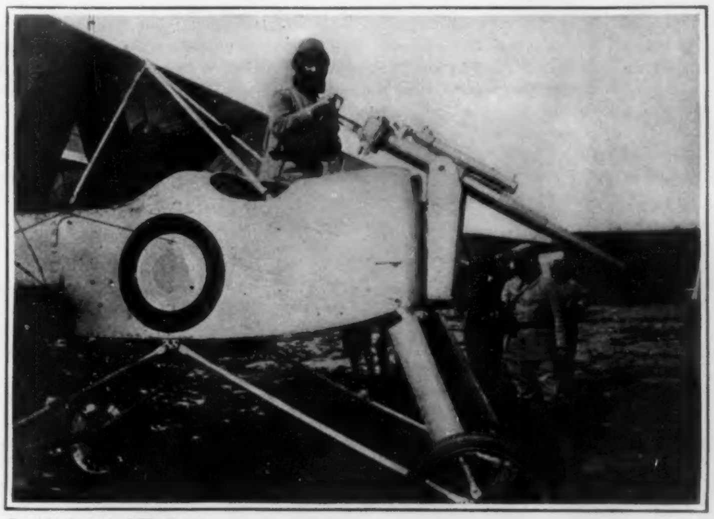
The action of the *avions-canon* was successful from the start; indeed, the protection they afforded to the bombing aeroplanes was so perfect that losses through German aircraft attacks had to be almost discounted, for even the most reckless bravery of a few German airmen could not compensate their inferiority in armament.

At about the same time there appeared over the Western lines the German version of the battle-aeroplane. This was a twin tractor Albatross biplane, whose two 165-horse-power Mercédès engines could furnish a top speed of well above 90 miles per hour. The armament consisted of two Maxim guns, mounted one fore and one aft on a central nacelle; the pilot sat between the gunners. The normal radius of action amounted to 8 hours' navigation, but if the fuel supply was reduced so as to last only for 6½ hours, 12 bombs, each weighing 10 kgs., could be added to the armament.

On a more advanced model of this machine the power plant consisted of two 225-horse-power Mercédès engines; the nacelle was armor plated, and a third Maxim (or, according to some reports, a small cannon firing grape shot) was added to the battery.

The appearance of this battle aeroplane was marked by an unprecedented execution among the aeroplanes of the Allies, for while the latter possessed a number of machines that were just fast enough to catch up with the dreaded "Arminius" (as the French nicknamed the "Teuton"), none of them carried more armament than one machine gun. As to the *avion-canon*, it had not sufficient speed to bring into play its powerful cannon, and "Arminius" was always clever enough to decline a fight with the French battle-aeroplanes.

Fortunately for the Allies, French ingenuity soon found a remedy for this terror of the skies. A special type of aeroplane-destroyer *avion de chässe* was at once commissioned by the French. This machine was nothing but the racing monoplane the Morane-Saulnier firm had built in 1914 for the Gordon-Bennett Cup. In the hands of all but an expert pilot this monoplane would have been of little use in warfare; but it was Gilbert, the celebrated airman, who led the first Morane against "Arminius" and the battle ended with the victory of the Frenchman, for the "Teuton" was set on fire.



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Nacelle and quick-firing gun of a French avion-canon

A retrospective review of this battle shows that a powerful aeroplane carrying a battery of two or possibly three Maxims and a crew of three or four (it fell inside the German lines, which precluded its inspection), was put out of action by a one-man machine, being 10 miles faster than its opponent, and in which the pilot acted as gunner. For the armament of the Morane destroyer consists of a machine gun built into the fuselage just in front of the pilot, which gun is aimed by steering the whole aeroplane against the target. The machine being a tractor, it is self-evident that the gun fires through the air screw; but in order not to injure it, the latter is protected by armor plating which deflects the bullets that may hit the blades. In this manner only about 30 per cent of the bullets are lost.

After Gilbert's feat had been repeated by two or three other pilots with equal success, "Arminius"—which was incidentally responsible for poor Pégoud's death—suddenly disappeared from the western front; all the machines of this type were then sent to the East to participate in the big Teuton drive against Russia, where aerial laurels seemed easier.

Nevertheless, the Germans were far from being discouraged that "Arminius" had not proven unbeatable, for soon afterward another type of German battle-aeroplane loomed up above the lines in France and Flanders. This was a single tractor biplane of the Albatros and the Aviatik makes, and was fitted with either a 180-horse-power Maybach or a 225-horse-power Mercédès engine furnishing a speed well near 90 miles per hour. While slightly slower than "Arminius," "Fritz," as the British called it, had a range of 10 hours flight; it carried in addition to ten 5 kgs. bombs, two Maxim guns, one in front, mounted above the engine, but firing sideways only, and one behind the pilot. Being sufficiently fast and responding much quicker to the controls than "Arminius," this machine maneuvered in such way as to range up alongside its opponent and discharge a broadside from both Maxims at once.

While in no way a match for the *avion-canon*, Fritz was undoubtedly superior to any one-machine-gun craft of the Allies, with the possible exception of the Morane destroyers; but of the latter only a limited number were available on account of the exceptional skill required for flying them. But it seems that the French had foreseen this contingency, too; and before Fritz could do much harm among the Allies, it was met and defeated by the speedy Nieuport tractor biplane.

There was nothing extraordinary in the latter machine; it was very fast, a good climber, very manageable, and of quick responsiveness; in general appearance it followed the orthodox lines of the well-known British "tabloids," such as the Sopwith, the Bristol, etc. But what inaugurated a new era in aerial fighting was its gun emplacement. Instead of mounting a Hotchkiss on the fuselage, either firing through the air-screw or backward and sideways, the Nieuport destroyer has its machine gun mounted on the top plane and the gunner operates it standing. This arrangement enables the pilot to attack an enemy from below before the latter is able to bring into play, after the necessary maneuver (bank, turn, or dip), its own battery. This novel system of gun-mounting cost the Germans a goodly number of machines, and eventually they adopted it themselves, with one variance, however, in that they added to the armament an automatic rifle that could fire backward. The mounting of the latter weapon is very ingenious; it is rigidly fixed to a pivoted seat, which can rotate in an arc of 180 deg., so that whichever side the gunner turns to the rifle always remains in front of him, ready for action. Such is the armament of the 165-horse-power Mercédès-Aviatik tractor biplane, which can be considered to represent, at the moment of writing, the latest all-round type of the German aeroplane destroyer,

(*Concluded on page 164.*)

* See SCIENTIFIC AMERICAN, Vol. CXIII. No. 10.

Vedrines in his Morane single-seater monoplane getting his machine gun ready for an aerial combat

Vedrines examining the automatic rifle of a German Mercédès-Aviatik tractor aeroplane which he captured single-handed

"Guard," opening of all bayonet attack

The thrust and parry

The lunge and parry

Bayonet Fighting

An Ancient But Indispensable Form of Combat

By Edward C. Crossman

ON the face of it, the most ridiculous phase of modern fighting is the fact of the efficiency of a sharp knife stuck on the end of a clip-loading, flat trajectory magazine rifle.

The contrast between the two weapons, the sharp knife and the rifle, is the contrast of 2,000 years. By itself the knife is not so efficient as the short sword of the legions of Cæsar. On the empty rifle the knife is not so efficient as the spears of the Macedonian phalanx.

Despite this queer mixture of the weapons of the pre-Christian era and the highest development of modern ballistics, there is good reason to believe that the bayonet is not only not doomed, but is to have still more attention paid to it after the present war.

It was logical enough in the days of the muzzle-loading rifle with the delay of a half minute or so from shot to shot, and the ridiculously close range at which our forefathers fought. It was logical enough when the rifles and muskets of those times would hardly hit a barrel at 100 yards, and would miss an ice-house at 400 yards. It was logical enough when the fashion of fighting sent cavalry galloping past the front of massed infantry until the fire of the footmen was drawn and the horsemen could smash and hew their way down through the close-packed ranks of men with empty rifles. Always horses disliked bayonets. When the infantry rally early enough to let the horses get a good view of the bristling, gleaming hedge that stands round each square, the steeds turn at the last moment and refuse to immolate themselves at the behest of their riders. Then the only recourse of the peeved cavalrymen is to lean far over and slash at the infantry with the long sabres given them for that especial purpose.

But those days are gone. Cavalry rarely charges in the face of magazine, clip-loading rifles. If it becomes thus incautious it merely helps to send up the prices of American horses. The normal infantry combat outside of entrenched positions, opens at 1,200 yards. The modern infantry rifle speaks thirty to thirty-five times a minute. It can be recharged with a fresh clip in 4 seconds from the last shot of one clip to the first shot of the other. It shoots into a circle the size of a barrel-head at 1,000 yards instead of at 75 yards. No smoke conceals the movements of the other force, bullets fly fast and flat, and do not miss because of slight errors in sighting setting.

With all this true, the use of a sharpened knife 18 inches long on the end of such a magnificent weapon as the modern rifle, would seem the act of a child or a madman.

But, not only has the sharp knife proved its usefulness in the close fighting between trenches, where one might expect sharp steel to prove useful, but it has helped Germans to drive Russians out of the most temporary positions where the fight started at long range, and it has, in turn, induced the Teuton to turn his back hurriedly on Petrograd and to commence an accelerated progress toward Berlin.

Up to the time of the Russo-Japanese war the bayonet had gradually fallen into disgrace. The experience of the British in the Boer war, in 1900, when the Boers had no bayonets, and the British found that the Boers had merely decamped, when they got close enough to the Boer positions to use their own, seemed to prove that the long knife was about as useful a part of infantry equipment as a pair of brass knuckles would be.

In 1903, between the Boer and the Japanese wars, the United States got out a new rifle, a modified Mauser, clip-loading, and of the most modern type. On this rifle, the new Springfield, our ordnance people put a compromise, the smallest bodkin that ever rifle wore. It was a rod bayonet that normally rested in the stock below the barrel like the old style ramrod. It extended about a foot beyond the rifle muzzle when in place for service, was about the size of a pencil, and had a sort of a point—that is a heavy enough lunge of the rifle would probably have inserted it into the anatomy of an enemy.

A low thrust and parry

Head cut and parry

The Japanese and Russians upset all the traditions of three years' standing, established by the Boer war. Probably a poorer exhibition of rifle shooting never was given than that put up by the Russians and Japanese, but they made up for their deficiencies by savage attacks with the bayonet in the face of all the machine guns and high explosives and magazine rifles that modern science had conjured up.

Immediately the United States shucked one-rod bayonet off its new rifle, and installed a formidable sword bayonet, carried normally in a scabbard like the bayonets of other powers, extending 16 inches beyond the muzzle of the rifle, double edged at the point, and sharp all the way down one edge.

Detached from the rifle and gripped by its very efficient handle, it makes no despicable weapon, it can be used to dig hasty and temporary shelters, and it can be slipped on the rifle in an instant. Of course, like all other bayonets, it does not interfere in the least with firing the rifle while it is in place on the muzzle.

The Russians have made more use of the bayonet than any other nation now at war, a natural result of poor riflemen, and a superabundance of soldiers, and a more or less half civilized people who naturally trend like all half civilized people, to the use of cold steel.

The Russian bayonet is never detached from the rifle, and no scabbard is provided for it. It is quadrangular in cross section, with the point chisel shape, and it is 16 inches long. The blade is set at a slight angle to the barrel, the point higher than the muzzle. Queerly enough the blade is browned or "blued" like the barrel of the rifle, aiding to protect it from the elements, but taking away from the effect of the bristling line of shining steel that the perturbed foe normally sees when attacked by the bayonet. The scare is half the effect in a bayonet charge; often the opposing troops do not wait to argue out the matter.

The few reports we get of the savage fighting of the Balkan wars of 1912, agree that the Bulgarians took to the bayonet at the slightest provocation, and that the Turks hastily left at the first sight of the long line of bright steel that suddenly appeared. One instance is given of the attack of a whole brigade with the bayonet that began at 400 yards. That is, the Bulgarians fixed bayonet and charged the Turks at a distance of four city blocks from the Turkish position. Unless supported by the most fiendish smothering artillery fire, the Bulgarians would have been wiped out by expert riflemen manning the Turkish position, but expert riflemen were scarce. At Kirk Kilisseh several brigades of Turkish recruits were pushed into the fight, so raw that they had been instructed but the night before how to load and fire their rifles.

Possibly the wooden bullets that the Bulgarians found in some of the Turkish cartridges at Kumonavo helped to weaken the Turks' usual courage.

The present war has gone far to prove the old claim of the infantryman, that infantry is queen of battles. You can pester the foe and learn of his movements with your cavalry, and you can pound his trenches to bits with your artillery, but you cannot take and hold his position without the infantry. Apparently we are to add to this the proviso that you cannot do this without the infantryman's bayonet.

The British are paying much attention to the bayonet in training their troops. Part of the training game is to rush an "enemy" trench, leap it, and plunge the bayonet into sacks on the other side representing the foe. Another phase is rushing man-size figures hanging by ropes and lunging the bayonet through them without halting the rush.

Of course, this is the field training. As preliminary training the recruits are carefully trained in attack and defense with the bayonet, just as men are taught to box. Giving no other odds to either side, the trained man can simply murder an untrained opponent.

In the American army, bayonet exercises are part of the course, and bayonet fighting with dummy rifles and blunted, light, springy rods for bayonets is well worth seeing.

Although the lunge of a bayonet-fitted rifle in the hands of a powerful man is amply sufficient to drive the blade through the ordinary door, the course of the blade is easily turned just as is the blade of the fencer's foil. A single lunge parried, and a quick lunge in return settles the contest between the untrained and the trained man. There is more difference here than there is between the boxer and the novice, because the latter

if he is strong, can always close and go to wrestling, while closing with a man at the other end of a bayonet-fitted rifle, is not so easy.

The sword bayonet is both a thrusting and a cutting weapon. Naturally the thrusting part of the programme is the fatal part, yet a cut of a sharpened bayonet may weaken or demoralize an opponent until he gives ground or falls victim to the lunge.

In the American army the soldier in bayonet fighting is taught to grip the rifle at the small of the stock or grip with the right hand, and the portion just ahead of the rear sight with the left hand, bolt handle upward, barrel toward the body, bayonet at the height of the chin, left foot extended, body balanced on the feet like that of a boxer on guard.

In our service there are only three attacks with the bayonet, but, strangely enough, the butt of the rifle is also utilized as an offensive measure, and this is part of the bayonet training.

In the three-bayonet attacks, the thrust is merely a quick drive forward of the rifle, without moving the feet, the butt at the height of the chin, the barrel to the left, the rifle lying on its side. The lunge is the same motion, a slight lifting of the rifle and a drive forward almost horizontally, but here the soldier advances the left foot as he lunges, thus throwing his weight behind the drive.

These two thrusting attacks are supplemented by the right and left cuts, the left cut, for example, done by slightly drawing the point of the bayonet to the right, then making a slash to the left by quickly extending the arms. The right is the reverse. With the ordinary half sharp blade this attack is of little importance, but with a sharp bayonet, whetted to a razor edge as the Bulgarians carried theirs, an attack of this sort, ending in a slash across the opponent's arms or hands, might speedily disable him.

The attack with the butt of the rifle, which is merely driven to the front, to the rear by a pivot of the body, or to the left or right, is useful chiefly for rioting, where the bayonet would not be used, or where close quarters did not allow the blade end of the gun to be brought into action.

The defense against these attacks are merely two sets of parries, the right and left, and the right low and left low. In the two, first mentioned, the parries are nothing more than short quick motions of the left or controlling arm, moving the bayonet point 6 inches or so the right or left of normal, and so catching the blade of the opponent's rifle. As the rifle on the defense is held firmly between the two hands, with the arms close in and the gun under full control, it is easy to turn off the blade of the enemy rifle which is of course extended at the length of his arms and easily deflected by the firm opposing blade.

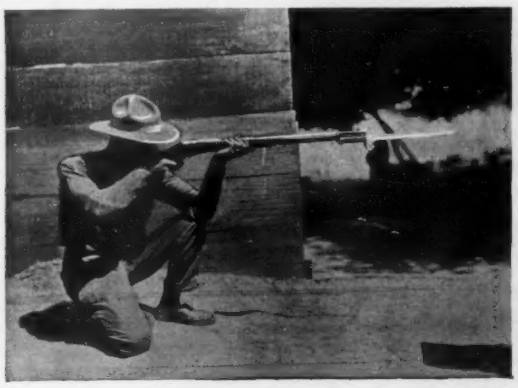
The danger to the tyro is that in parrying he may move his bayonet too far in his anxiety to get the threatening blade as far to one side as possible, lose his chance for a return thrust, and open himself to the real thrust of which the first was only a feint.

The combination of these simple movements makes a dazzling attack and defense in the practice bayonet fighting in the regular service. Anyone who has ever watched these contests between practiced bayonetmen will agree that, as stated, a fight between the trained bayonet fighter and the untrained man, is merely slaughter.

In the breasts of many people cold steel arouses a thrill of horror, not inspired by the knowledge of the power and "undodgability" of a bullet. Doubtless this is why so many positions are evacuated on a bayonet attack without waiting for the final argument.

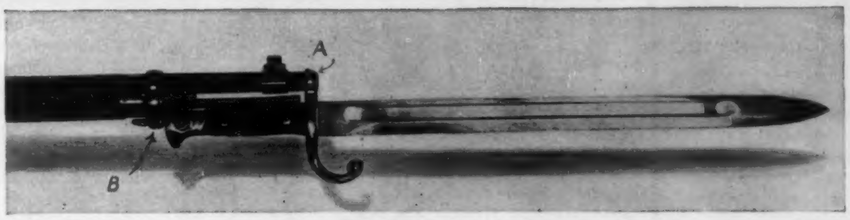
On the other hand, the bayonet is dangerous just so long as the arms and the rifle will reach, and the danger is always in sight and always avoidable by giving ground or superior skill with the same weapon. The bullet is dangerous, clear to the horizon, cannot be dodged, carries no if's and and's as to penetration, and all in all, knowing both bayonet and bullet as well as I do so far as peace experience will let me, I would prefer the bayonet to one shot from the rifle.

Bayonet mounted on an old-time rifle



A bayonet fixed in position does not interfere with the firing of a rifle

On an old-time military rifle of this type, the bayonet was indispensable



Standard attachment of sword bayonet

Ring in belt of bayonet slips over muzzle at *A*. Dovetail slot with spring stud engages stud at *B*.

The Current Supplement

THE leading article in the current issue of the SCIENTIFIC AMERICAN SUPPLEMENT, No. 2092, for February 5th, on *The Structure of the Atom* covers a problem that lies not only at the foundation of chemistry, but of electricity and, in fact, of all physical science. The present article is of unusual importance, and is by one of the greatest authorities on the subject. A short illustrated article on *Grenades, Rifle and Hand*, gives an excellent idea of the construction of some of the smaller projectiles now being used in the European war, and how they are used. A somewhat similar article on *Throwing Bombs from Airships* describes how these explosive shells are dropped from a fast moving air craft so as to hit a desired object on the ground. *Some Notes on Optical Glass* outlines the processes of manufacture, and explains the nature of various imperfections and the means of obviating them. *The Region of Greatest Snowfall* tells of a startling extreme exhibited by the climate of California, and there are a number of unusually interesting photographs to illustrate the subject. The important article on *Our Merchant Marine* is concluded, as well as the article on *Oil Mixed Portland Cement Concrete*. *The Alternating Current Single-Phase Induction Motor* is a simple explanation of how this machine runs, and why it runs. This will be welcomed by many readers who hesitate to attempt an intepretation of the intricate mathematical explanations usually given. Among the shorter articles of interest is *A Mechanism of Protection Against Bacterial Infection*, and *The Consumption of Shells*, that gives some facts relating to the number of projectiles being used in the war, and their production.

The Campaign Against Cancer in New England

THE New England States generally show a higher death rate from cancer than any other group of States. This does not mean that New England people are more susceptible to this disease. Cancer is a disease of later adult life, and it is well known that in parts of New England there are more old people proportionately to the population than in many other regions. Nevertheless, the death rates recently published by the U. S. Census Bureau have stimulated much activity in these States in the educational campaign for the immediate control of malignant disease.

What are the facts upon which this movement is based? According to the report of the Census Bureau, in 1913 there were 49,928 deaths from cancer in the registration area of the United States, corresponding to a death rate of 78.9 per 100,000 of the population. All the New England States have individual cancer death rates much higher than this. Connecticut's rate, which was the lowest of any of the New England States, was 85.1. Vermont's rate was the highest with 111.7, while the rates of the other States were correspondingly high, Maine having a rate of 107.5, New Hampshire 104.4, Massachusetts 101.4, and Rhode Island 93.3. When these figures are compared with those of Kentucky, with a rate of 48, they seem indeed very high. They mean that 6,817 people died in 1913 in New England from cancer. But it does not necessarily follow that cancer is more common in New England than elsewhere. The Census Bureau attributes the high cancer death rates in certain districts to the relatively high age distribution of the population and the negligible amount of immigration. Translated into every-day terms, this means that in New England the proportion of people over forty years of age, or at the cancer age, to those under forty, and so less liable to cancer, is greater than in other places. Yet there is no doubt that the cancer death rate in New England, as well as in other parts of the country, is much higher than it ought to be. Without question a large percentage of cancer deaths can be prevented by early recognition of the symptoms and prompt recourse to competent surgical advice and treatment. Cancer is not a hopeless incurable affection, as so many people wrongly believe. Those who know the facts believe that if the public can be properly educated in regard to the early signs of the disease and will act on this knowledge, the present mortality should be reduced at least half and perhaps two thirds.

That New England is awake to this opportunity of saving lives is evident from the activity in several States. To protest against taxation without representation the patriots of Massachusetts dumped overboard the famous cargo of tea. Vermont medical men have become so concerned over the high cancer death rate of their state that they are going to hold a "tea-party" of another sort and attempt to dump overboard the high death rate from malignant disease. While their action is not so dramatic as that of the patriot raiders, they hope to prove that through its great ultimate benefit to the community it will be almost as patriotic. The New Hampshire State Board of Health has recently published sound advice in its *Bulletin*. In Maine an active committee of the State Medical Society is arranging public lectures and causing the publication of instructive articles in the newspapers. Massachusetts has a well-organized branch of the American Society for the Control of Cancer with headquarters in Boston. The Vermont State Medical Society has arranged a series of public meetings to spread the bad news of the high cancer death rate and the good news of the hope of controlling the disease by earlier recognition and prompt surgical treatment. Morning, afternoon and evening meetings will be held on Tuesday, Wednesday, Thursday and Friday, June 8th to 11th, at Rutland, Burlington, Montpelier, and St. Johnsbury. The Vermont State Board of Health will send its secretary, Dr. Charles F. Dalton, to address each of these meetings, and the American Society for the Control of Cancer will be represented by Dr. Francis Carter Wood and Dr. J. M. Wainwright.

Strategic Moves of the War, January 27th, 1916

By Our Military Expert

IT would be rather presumptuous, owing to the paucity of information from various theatres of war, to say whether certain military operations were of the nature of major movements or only incidentals, for apparently insignificant conditions may contribute decisively to victory or defeat. The mere destruction of a bridge, thereby delaying the arrival of reinforcements at a critical time has ere this affected the outcome of wars. For this reason, while one is apt to dismiss the operations in Armenia and Mesopotamia carelessly, almost as though taking place in another planet, they may, in some way now unknown, become of vital importance—possibly through the necessity arising for the dispatch to this section of heavy Turkish forces at the expense of another.

The Erzerum section is very remote for purposes of Turkish reinforcement. There are no railways leading into this theatre, the roads are not of the best, the country is broken and forbidding and the distance from central garrison points is almost prohibitive.

The use of the Black Sea as an avenue for the passage of Turkish forces is beset with menace. Russia has her Black Sea fleet principally employed in watching the coast line and the armada which would sail for Trebizond from a Turkish point, would be rash indeed—foolhardy would be a far better word.

The Russian operations in the Caucasus have extended from the sea to the shores of Lake Van, the large body of water about 200 miles southeast of Erzerum. The battle-line is not continuous, of course, for geographic features permit the employment of detachments of greater or less size, only nominally in contact with lateral forces.

Latest dispatches indicate a material Russian success in the center, directly before Erzerum, recounting the virtual rout of three Turkish corps, backed up by the Erzerum garrison afield.

The campaign began effectively in the early autumn and almost immediately resulted in local successes along the seacoast, near Olti, and in the Lake Van region. The Russian flanks were secured, defeat of the Teutonic forces near Urumiah contributing materially.

The massed Russian movement against the center commenced in December, during which the Turkish army attempted to double up the flank near the sea, but without avail. As a result of the failure and the breaking of the center, general retreat toward Erzerum became necessary. Apparently the Russian forces were sufficiently in hand to undertake pursuit, for according to reports, the retirement still continues.

Erzerum lies in the province of the same name in Armenia and is about 110 miles southeast of Trebizond, a Black Sea port. About the same distance to the northeast of Erzerum lies Kars, a railhead which must be the main Russian base. Slightly to the westward, the Kara, or Western Euphrates river winds to the southwest, being joined by many confluents.

To the south of Armenia is Kurdistan, a territory equally rough, equally difficult. It is over this terrain that any further material Russian advance must be made should conditions permit the thrust.

About a hundred miles southwest of Erzerum is the city of Erzingan on the Western Euphrates. While of little material importance commercially, a number of practicable roadways center here, making it a probable point of objective in the future. The Euphrates is considerably more of a stream at this point than at Erzerum, and is an available means of supplying a further advance.

South of Erzingan and southwest of Erzerum is Kharput, another road-junction of importance. Owing to the mountain ranges which almost seem to interlace, an advance upon Arghana, which is about thirty-five miles southeast of Kharput, must first pass in the vicinity of the latter place before swinging to the southeast.

Arghana is near the source of the Shat, the Western Tigris, along whose banks at Kut-el-Amarah about 450 miles to the southward, British forces are striving to hold on in the face of superior strength until the British relief expedition can carve a way to the rescue—if it ever does. But the Eastern Euphrates is north of Arghana, running almost east and west, and constitutes a natural line of defense which must be forced before the Tigris can be reached.

It is therefore evident that if the objective of the Russian movement in the section is to combine with the British allies, the Tigris must be gained—and it is a long, hard passage which confronts the undertaking. The existing problems of supply and transportation belong to a past era of military operations, when commanders had not learned to lean heavily upon a network of railways to supply their many wants and which permit the prompt shifting of troops from point to point; the situation calls for the resourceful genius of a Bonaparte or a Stonewall Jackson, both of whom seemed to find their greatest measures of success under similar circumstances, when mountain barriers were utilized for concealment of movement, division of forces and defeat of an enemy in detail.

The recent observation of a British officer that strategy is a lost art, remains to be proven or corroborated, for the operations in the Caucasus call for—and will continue to call for—exercise of this art to an *n*th power.

According to Constantinople admissions, the Russian force in the Caucasus section is superior to Turkish. Under the advantage of the defensive to-day, owing to modern armament which provides a much heavier volume of fire and a far greater range than formerly, and in view of the character of the theater of war, tremendous losses must be sustained in any direct attack against fatalist forces which are apt to stand to the last and fight it out breast to breast. On the other hand, the railway base advantage lies with the Russians, for Kars is nearer the front than any Turkish resource can supply and the feeding-in of reinforcements and materials should be easier.

When the Dardanelles campaign was abandoned by the Entente, it is reported that a considerable number

Russian operations in Turkey

of Turkish troops and some German forces were dispatched to the Caucasus front without delay. The distance is great and almost the entire journey must be made by marching with accompanying difficulties of supply. The weather is now bitterly cold for such a venture and the resource of the country does not lend itself to any great extent to sustenance.

As a corollary, it will take just as long to shift these forces back to Turkey proper, or to the Balkans, should the situation demand it.

The section of the Russian general advance is reasonably well secured. The right is covered by the seacoast—and is further secured by the Russian fleet which blocks the landing of an attacking force in the vicinity. Northwest of Erzerum, mountain chains interpose between the Black Sea and the valley of the Western Euphrates, while other range-spurs and lesser chains are freely scattered east, west, south and north. The entire country is alternately mountain and valley, with here and there moderate plateaux, until Kurdistan and the lower Tigris are cleared.

To the eastward, Lake Van establishes a splendid pivotal point, easily defended and secure from molestation. Hordes of Cossacks are reported to be operating in the vicinity of Van, not only in reconnoisance and screening but in good, old-time shock-action which carries one back to the days of the Empire.

That the Russian offensive is deliberately aimed at a junction with the British movement from the south, is to be doubted. Certainly the English forces on the ground are insufficient to lend much probability of success to maintaining their end of the bargain. It would appear to constitute much more of a direct thrust at the Turkish interior, to the detriment of supplies, availability of men, isolation of part of the territory of the Ottoman and moral effect. The very strength of the operation suggests the reflection that Russia must have a greater number of men available for use on lines of battle than can be used on her main line against Germany and Austria and that the question of arming, equipping and supplying her forces has been reasonably solved; for necessarily the extension of her battle lines would never be undertaken by a country in desperate straits—on the contrary, under such conditions the lines would be restricted as much as possible, to make for concentration.

The military resources of the Turkish Empire are not great. With a population of twenty million people, in both European and Asiatic Turkey, an eight per cent basis of estimate for available man-power results in 1,600,000 bayonets. But it is hardly reasonable that this number is available, on account of the non-existence of railways to bind the sections of the empire together. If, then, Turkey has a million men in the field, it is the result of German insistence, organization and assistance.

Of this number, there are possibly a hundred thousand engaged in the threat against Saloniki; a hundred thousand in the vicinity of Constantinople; a hundred thousand along the lower Tigris; three hundred thousand scattered along the Caucasus line and immediately in reserve. A general remainder of four hundred thousand should be necessary for garrisons elsewhere, internal police, recruiting and supply and general reserve.

On the other hand, Russia's population of 165,000,000, on an 8 per cent basis gives 13,200,000 men available for military use.. This staggering force cannot possibly be equipped or actually in use at the present time; eight million is considered an over-liberal estimate. Probably from three to four million Russians occupy the main line, from Bessarabia to Riga, including the forces held in local reserve and on the battle-front communications. Another two millions should be engaged in general reserve, supply and police in the interior; from the remainder not accounted for, a force varying from half a million to a million men should be available for use in the Caucasus and it is believed that developments will indicate the local strength as lying between these figures. It is certain that as things now are, Russia should have preponderant strength in Armenia; it remains to be seen whether it is ample to create an acceptable diversion or secure a material victory to the Entente cause.

Horse Manure Kills Flies

ON the battlefield M. Roubaud observed that horse manure was in the first place a propagating place for flies which are so thick in some of the trenches, but as he states in a note presented to the Académie des Sciences, this may, in turn, act to kill the flies, or rather the larvæ. In fact, the fly lays her eggs in fresh manure, but when it is several days old she no longer does so, for this ferments very rapidly and the temperature rises to 60 or 70 deg. C. Such an elevation of temperature is fatal to the larvæ, and they are killed within 3 minutes at 50 deg. and in 4 or 5 seconds if at 60 deg. Hence it results that the best way to kill the flies is to bury the fresh manure with its larvæ, inside the pile, and if this is done, 90 per cent of the larvæ will be killed. This is an appreciable result when it is noted that a cubic yard of material can contain 35,000 eggs.

Ball Extracted from the Heart

DR. INFROIT made a communication of a remarkable character to the Académie de Médecine, concerning the extraction of a shrapnel ball lodged in the heart of a wounded man, in the right auricle. This operation shows the great progress which is being made in localizing objects by means of radiology, and Dr. Infroit makes use of the new "radiological compass" invented by him. Owing to the great precision of this apparatus, he is able to extract foreign bodies of all kinds, such as uniform buttons, plates or badges, coins or various projectiles lodged in the lungs, brain, liver, and other organs of the body. One of his recent operations was the extraction of a large coin (5-franc piece) from the abdomen. Owing to the great exactness of the localization, the organs are not injured during such very delicate operations.

Correspondence

[The editors are not responsible for statements made in the correspondence column. Anonymous communications cannot be considered, but the names of correspondents will be withheld when so desired.]

Problem of the National Guard

To the Editor of the SCIENTIFIC AMERICAN:

In your January 8th issue, "Patriot" answers my article published in your November 27th issue; and, because he has made some mis-statements therein, I am constrained to ask you to print the following:

He says that because the labor union men are opposed to the militia, or the guard, on account of its service in times of strikes and riots that the regular army alone should be assigned this duty thus enrolling the labor union men in the militia. This course would, no doubt, increase the militia greatly. But, assuming his proposal be adopted, can he not see that it would be only a question of time until the labor unions would oppose the regular army for the same reasons they oppose the guard now? Can he not see that this would create a serious obstacle in the path of adequate preparedness? He says that it would be very foolish to put other than the best man on the job. Will he consider thoughtfully the seriousness of, and the foolishness of, our regular army contending with unorganized bands of militia?

In his second paragraph he intimates that the guard is lacking in brawn. I, of course, have no facts to refute it; but I will ask him to note carefully during his next tour of duty whether the laboring man possesses all the brawn.

His high minded citizen does not cast a slur on the guard on general principles. His high minded citizen supports the guard in the State of Texas where support is eminently needed. The slur to which he probably refers is paragraph 3. If "Patriot" will do me the justice to re-read my article, he will surely retract his statement; for I very carefully qualified the first sentence with the words, "compared to a genuine military force"; and surely for militia to be exempt from militia duty would be omitting its cardinal duty. I haven't the slightest doubt that practically all the officers and men in the guard are there for war only, not strike duty; but what is to be done?

"Patriot's" fourth paragraph: He should know that the dual command of the guard is one of the serious faults of the establishment. He should know that it is only after the President proclaims a state of war, or imminent danger thereof exists, or there is rebellion against the constituted authority of the United States, that he can call the militia into the service of the United States and send them any place within the continental limits of the United States. Who was in command of the Texas guard when the Governor of the State ordered a regiment of infantry, two troops of cavalry, a battery of field artillery and a hospital detachment to the Mexican Border in April, 1914, at the very evident displeasure of the President? Who was in command of the South Carolina guard when the Governor of that State recently disbanded the entire organization? Who will be in command the day war breaks and what will happen? I am familiar with the control the Division of Militia Affairs exercises over the guard, but that is not "supreme command." It should be, of course, in time of peace; because it is planned to be in time of war. He has no doubt that the present Congress will make the limits where the guard may be sent any place under the flag. A study of the constitutional difficulties will dissipate this expectation. Even if it were thus I fail to understand the military strategy of planning our next campaigns on our own precious soil.

In his next paragraph he says, "Likewise the statement is wrong that the last Congress made provision for enlistment in the regular army for a term of eight months." This statement makes my reply necessary. Will he please read again my article and acknowledge his mistake? I thought that a national guardsman would immediately recognize the new volunteer bill when I mentioned the transferring into the volunteers; but he does not seem to be familiar with it. If he will refer to War Department Bulletin No. 17, May 1st, 1914, he will find what is referred to in my first paragraph, and if he will read my second paragraph, he will find that the eight months have no connection whatever with the volunteer bill mentioned.

Instead of exempting the guard from riot duty on a false theory of right and wrong, what is needed is universal compulsory service in the guard; the appointment of its officers by the President; the supreme command vested in the President; the provision of suitable authority for the Governors in times of riot; and the perfection of the plan, by making all necessary preparations, to transfer in time of war national guard organizations into the volunteers.

I concur in the belief that eight months is not long enough to make a soldier. It is too bad that all patriots and citizens do not believe it. It was only suggested.

In conclusion I take the liberty of using "Patriot's" concluding paragraph, substituting for the second word, "allowed," compelled.

CITIZEN.

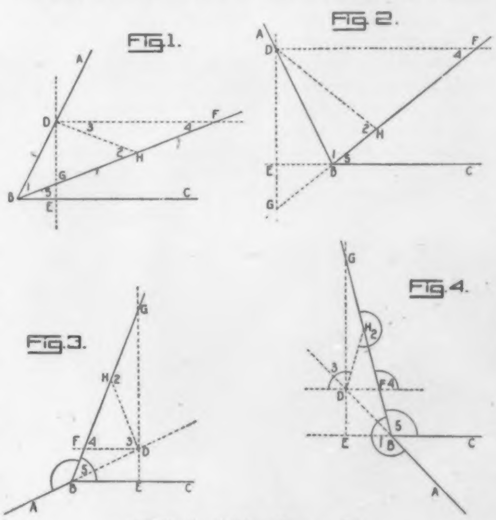
Trisecting an Angle with a Ruler

To the Editor of the SCIENTIFIC AMERICAN:

I was much interested in the method of trisecting an angle as given on page 271 of your last volume. The conchoid curve and the machine for drawing it are unnecessary, however, and the same accuracy may be obtained with a ruler and dividers. Moreover the following method, though based on the same principle as that given, is not confined to the trisection of acute angles, but applies equally well to the trisection of obtuse and reflex angles.

To trisect the angle ABC:

From D on the line AB (or AB prolonged) draw DE perpendicular to BC (or BC prolonged) and draw DF perpendicular to DE. Locate the perpendiculars so that DF, if prolonged, will cut the bisector of the angle ABC inside the angle. Figures 1 to 4 show an acute angle, an obtuse angle and two types of reflex angles and the treatment of each. On a ruler or straight edge lay off



Method of trisecting angles

a distance FG equal to twice DB. Now adjust the ruler so as to bring the point F on the line DF and the point G on the line DE while the edge of the ruler passes through B. Draw BF. The angle FBC is one third the angle ABC.

Though the details differ in each figure the proof may be outlined as follows for them all:

To prove angle ABF equals two times angle FBC:

Draw DH bisecting FG at H. By construction and plane geometry BD = DH = HF = HG, forming the equal sides of several isosceles triangles.

$$
\begin{aligned}
\angle 1 &= \angle 2 \\
&= \angle 3 + \angle 4 \\
&= 2 \times \angle 4 \\
&= 2 \times \angle 5 \\
\angle ABF &= 2 \times \angle FBC.
\end{aligned}
$$

Has anyone a method for dividing an angle into five, seven or eleven equal parts?

WM. S. CHAPIN.

Vanderbilt, Mich.

The Wireless Amateur and Preparedness

To the Editor of the SCIENTIFIC AMERICAN:

Heretofore the activities of the "Amateur" wireless man have attracted little attention from the public, and at times even been viewed with more or less disfavor by the Government, but since the question of preparedness has come into such prominence, it has been discovered that the United States has in its amateur wireless operators a military asset of prime importance, and this for reasons so plain that anyone can understand them.

Everyone knows that a certain proportion of trained wireless men forms an indispensable part of every modern army and navy, and everyone who has given the subject any thought, must also realize that the great reserve force now contemplated by our country would require the services of operators by thousands. The ordinary telegrapher is not a radio operator, and could not become such without months of training. The commercial wireless service could not be drawn upon, for its numbers are not sufficient and it is even in time of peace short of men. Where then would the Government get its radio operators in case of war? There is only one possible answer—from the ranks of the amateurs.

As to the number of men that would be required, it may be noted that since the war began, the British navy alone has required the services of 5,250 radio operators!

Thanks to a liberal and characteristically American Government policy, we are fairly well off in this regard, the latest list of radio stations showing that we have 5,073 stations, of which 3,836 were licensed amateur stations, the balance being Government, commercial, and ship stations. Of course some of the amateurs are mere beginners, but a large number have become first-class operators, and having worked from the bottom up, without much encouragement, even making their own apparatus, and overcoming each obstacle as it appeared, they possess a more thorough understanding of the art than can be had in any other way.

Besides enlisting in the army, there are several other ways in which the amateur radio men would be of service to the country in the event of war. Our country is so vast in extent that it would be impossible for the Government to maintain a sufficient number of stations to listen for enemy or spy stations in our own territory, but the amateur stations are everywhere, and it would only be necessary for the Government to pass out the word to listen, and it would at once become impossible for any spy station to work without being discovered.

The foregoing facts should be considered by everyone interested in preparedness, and the Government induced to give the "amateur" every encouragement.

J. V. PURSSELL.

Washington, D. C.

Does the Ether Revolve?

To the Editor of the SCIENTIFIC AMERICAN:

On reading your answer to D.S.C., 14010, in the January 15th issue, Department of Notes and Queries, it occurs to me to suggest that since the sun is rotating and since every tangible object in this universe is revolving around the sun, is it not a reasonable supposition that the ether within this solar system is likewise in movement, rotating with the sun as a center.

Taking this hypothesis, even were the ether of measurable density, there would be no friction except as the revolving ether of this solar system met at the outer confines the ether of other solar systems.

I have studied to some extent the action of gases under compression and expansion, having carried pressure to 10,000 atmospheres on liquids and gases, and cannot help taking exceptions to the commonly accepted versions of some things such as the depth of the earth's atmosphere, the character and density of interstellar atmosphere or ether as ordinarily known for want of a better name.

One who has observed the actions of gases under varied temperature and from comparative vacuum to extremely high pressure, can hardly count the depth of earth's atmosphere in tens of miles, but rather in thousands of miles before it approaches the extreme tenuity of space midway between earth and sun. Neither can one conceive of a vacuum produced by gravitational attraction. In my humble opinion, as a student of physics and not as an astronomer, interstellar space is filled with hydrogen highly attenuated or helium or both.

In this vast ocean of space, there may be floating, unseen, worlds of gas or gases, invisible, yet each as capable of holding its individual position as part and parcel of this or some other solar system as are the more solid, substantial and visible worlds.

Some years ago, during the reign of Halley's Comet, I published a theory to the effect that a comet is a vast ball of luminous gas containing a central nucleus of solid or semi-solid particles of sufficient density to cast a shadow under the light of the sun. This explains the luminous tail of the comet; the curvature of the tail; the invariable direction of the tail, etc.

A gaseous body cast off from the sun by some great eruption or explosion would obtain and maintain a spherical form with the heavier gases liquefied, frozen, or solidified in the center of the sphere. The central portion or nucleus may be reasonably supposed to be liquefied gas with particles of solidified heavier gases floating therein at depths according to their density.

Every body in space must have an atmosphere. It need not necessarily consist of nitrogen and oxygen but, in their absence, or of the heavier gases, there will inevitably be hydrogen or helium of a density in proportion to the size and weight of the central body.

Gases liquefy more readily in proportion to their density and less readily as they become more tenuous. Does the atmosphere of our earth become sufficiently reduced in pressure before a degree of cold sufficient to liquefy is reached? If not, then there must be a continuous rain of liquefied air in the outer confines of the earth's atmosphere.

I trust that my observations may not appear as ridiculous to you as did to me a paper read by an "astrologer" before a scientific society in Los Angeles just before the visible period of Halley's Comet. He said that it would be a very wonderful sight when, on—(giving date of perihelion) the comet would "*swish around the sun.*"

GEO. H. LEE.

Omaha, Neb.

Keeping an Army Supplied

How Fighting Men of Germany Are Victualled and Munitioned

By Dr. Alfred Gradenwitz

NOTHING more strikingly illustrates the difference between the old and new methods of warfare than the evolution that has taken place in the victualling and munitioning services. Though Napoleon, in most of his wars, was able to follow his famous principle that "war must feed war," he, very much to his detriment, experienced the limitations of this system.

In wars of the present day, with their unprecedented numbers of combatants and novel and complicated exigencies, it is, of course, out of the question to attempt a course such as that suggested by the great general; the food requisitioned in occupied districts being at most a small contribution to the invading army's needs. In fact, an army, to be really capable of prompt and efficient action, must carry with it all the divers things it stands in need of. It is true that modern means of communication, in conjunction with the telegraph and telephone, afford a practically unbroken connection with marching and battling armies, on the one hand, and the base and home country, on the other; the electric spark allowing the requirements of the army to be signalled in a few moments to almost any distance, while a goods train, within 24 hours, brings the daily requirements of a whole army corps to a distance of 500 kilometers. In the victualing and munitioning of an army, nothing should be left to chance.

It is not generally realized how complicated an organization is required to keep an army permanently supplied with the food, ammunition, and sundry materials needed by the men and guns. Many, it is true, have a vague idea of the existence of what German soldiers in their own slang call "gulash cannons"—field kitchens taking the food to the men in the trenches or behind the firing line; but the fact remains that there is a prevailing ignorance among laymen in the matter of how an army is fed. They do not understand that these useful contrivances, of which, together with their supply wagons, there is one to every company, squadron and battery, are but the last link in a long chain of supply centers.

The field kitchen and supply wagon are fed from what in the German army is called the "big baggage"—an endless train of trucks following behind the army at from 5 to 10 kilometers distant and carrying not only food and ammunition, but also entrenching tools, sanitary material, reserve horses, fodder, and other war supplies.

In spite of the apparent magnitude of this train of wagons, the supplies of the "big baggage" at most suffice for but four to five days, and accordingly have to be continually replenished from the wagons and storehouses of the "army service" or "train," as it is termed by the Germans. Between the latter and the "big baggage" there is a continuous stream of motor cars traveling to and fro. And since not even the "army service" columns are inexhaustible, a continuous supply from the home country must be provided for. How this is achieved will be best understood by referring to the other end of the long supply system connecting the home country with the armies in the field.

Each army corps has, in the home country where the army base commences, a supply center of its own where all the food, fodder and ammunition required are gathered and sent on to the collecting station. Transport through the base proper now begins, either by rail, motor car, river barges, or other means, and continues as far as the district immediately behind the firing line.

Typical road behind the lines, showing the long streams of supply vehicles and men

Where regular railroads end, there is what is known as the base center ("Etappen-Hauptort"), where not only the supply of victuals and ammunition, but also the field post and other military services are centered. The farther transport is effected by means of field railways, motor cars, and the like, to the local base centers, the arrangement of which, of course, varies in accordance with the varying position of the army. Since the same roads—which, as a rule, are only few in number and in a bad state of repair—serve for a number of other transports, such as for troops proceeding to the front and for wounded soldiers and prisoners returning to the army base, the army authorities often experience some difficulty in insuring a reliable conveyance of supplies.

From the local base centers the final distribution of supplies to storehouses behind the front is effected by means of "army service" columns or motor trucks, and from the storehouses the "big baggage" of the various army corps is fed in its turn.

The standard daily ration of German soldiers in the field comprises 750 grams of bread, 375 grams of meat, 1,500 grams of potatoes, 25 grams of salt, 25 grams of coffee, and 17 grams of sugar. This, however, does not mean that soldiers get invariably the same amount of identical foodstuffs. In fact, these are merely standard quantities which, in accordance with the actual bill of fare, are replaced, partly or wholly, by equivalent amounts of other foodstuffs—bread, *e. g.*, by biscuits, potatoes by vegetables, rice by oatmeal, coffee by tea or cocoa, and so on.

In order to provide for emergencies, each German soldier carries about him what is called the "iron ration," which consists of a handful of food to be used only in cases of extreme need.

The food and ammunition supply of an army doubtless is one of the foremost features on which a military success eventually depends.

How Shrapnel Shell Is Made

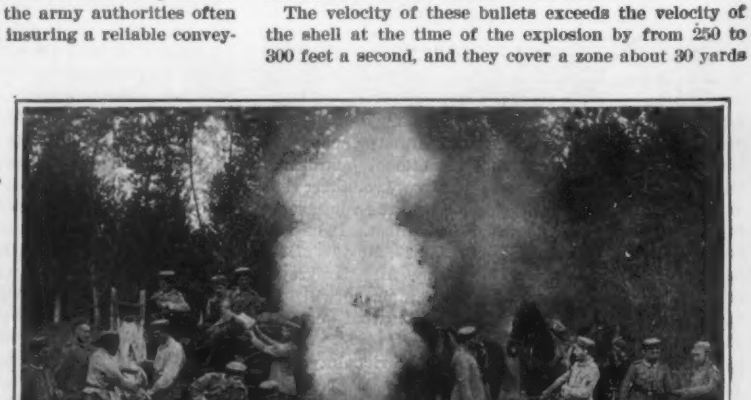
THE first shrapnel shell, invented in 1784 by Lieut. Shrapnel, was merely a cast iron ball filled with bullets and powder, which was exploded by a crude fuse, screwed into the shell. This type was unsatisfactory, because bullets flew in all directions when the shell exploded. Later this defect was partially overcome by inserting a sheet iron diaphragm, which separated the bullets from the bursting charge. Modern shrapnel is similar in principle to its early predecessor.

A superficial examination of a shrapnel shell discloses little to indicate its destructive power—it is simply a small steel shell, attached to the end of a brass case, but when properly adjusted and fired from a modern field gun, this becomes a veritable demon of destruction. Within the brief period of 4¾ seconds it has traveled more than 1 mile, and 17¼ seconds later, it is nearly 3¾ miles distant from the gun.

Each shell has a time fuse that is made with the accuracy of a watch. This fuse is graduated in seconds, and is set to explode at a given range. As soon as the gun is fired, the fuse is ignited automatically, and when the explosion occurs in the base of the shell itself, the forward end is blown out and a shower of lead bullets hurled forward in conelike formation.

The velocity of these bullets exceeds the velocity of the shell at the time of the explosion by from 250 to 300 feet a second, and they cover a zone about 30 yards

Heavy, horse-drawn wagon used by the commissary division of the German army



Distribution of food and other supplies to a company of soldiers in the field

Horse-drawn cars carrying supplies behind the battle line

A column of soup wagons or so-called "gulash cannons"

A battery of German bake ovens and bakers in the field

wide and 250 yards long, on an average.

The shrapnel used by different governments at the present time are made on the same principle, but differ somewhat as to size and in the arrangement of the fuse, which is composed of a slow-burning composition that is pressed into annular grooves. One of these grooves is in a stationary ring and the other in a graduated movable ring.

By turning the ring the length of this fuse is varied so that the shell may be exploded at any time within a period of about 21 seconds. During this brief period a 3-inch American shrapnel will travel about 6,500 yards, or nearly 3¾ miles.

Shells of the 3-inch size contain from 210 to 360 lead bullets, about one half inch in diameter, which are embedded in a resinous mixture. This "matrix," as it is called, serves two purposes. It holds the bullets in position and also acts as a tracer to indicate by a cloud of smoke the point at which the shell explodes.

The interesting phases of shrapnel manufacture include the formation of the brass case, the forging of the shell, and the finishing of the various shell and fuse parts, to the degree of accuracy required. The making of a brass case 11½ inches long, 3⅜ inches in diameter, for the British 18-pounder requires seventeen different operations. It is formed from a flat circular blank 6¼ inches in diameter and ⅜ inch thick.

As these cases, as well as those for other kinds of ammunition, contain about 65 per cent of copper, the importance of this metal in modern warfare is apparent.

The shell is forged to approximately the required shape, either in a powerful hydraulic press, a power-forging machine, or an ordinary power press, such as is used in sheet metal work. The presses used for forming these hollow shells from a solid billet are capable of exerting a pressure of several hundred tons.

For finishing the interior and exterior of a shrapnel shell many different designs of turning machines are in use. The tools are so arranged that one follows the other progressively, so that the drilling, turning, boring, forming and threading, are done rapidly and accurately. The exterior surface is finished smooth, and shaped to the proper size by a broad grinding wheel.

The final step in shrapnel manufacturing is that of assembling the different parts. A charge of black powder is placed in the bottom of the shell. Over this charge is a steel disk or diaphragm, and then the remainder of the space is filled with shrapnel and the smoke producing matrix. The time fuse is screwed in place at the forward end and covered with a soft metal case to protect the different parts. This outer case is removed just before using the shrapnel.

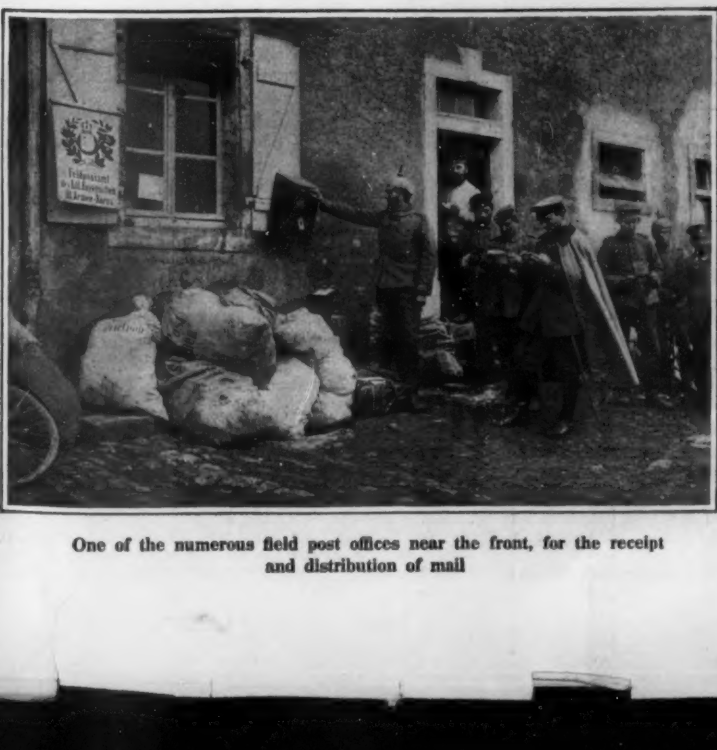
It is important that the steel from which these shells are made has sufficient strength to prevent any bulging of the shell when it is subjected to the enormous pressure at the time of firing.

An ingenious little instrument known as a scleroscope is used for making this strength test. This instrument has a small hammer, tipped with a diamond, which is allowed to drop upon whatever part of the shell is to be tested.

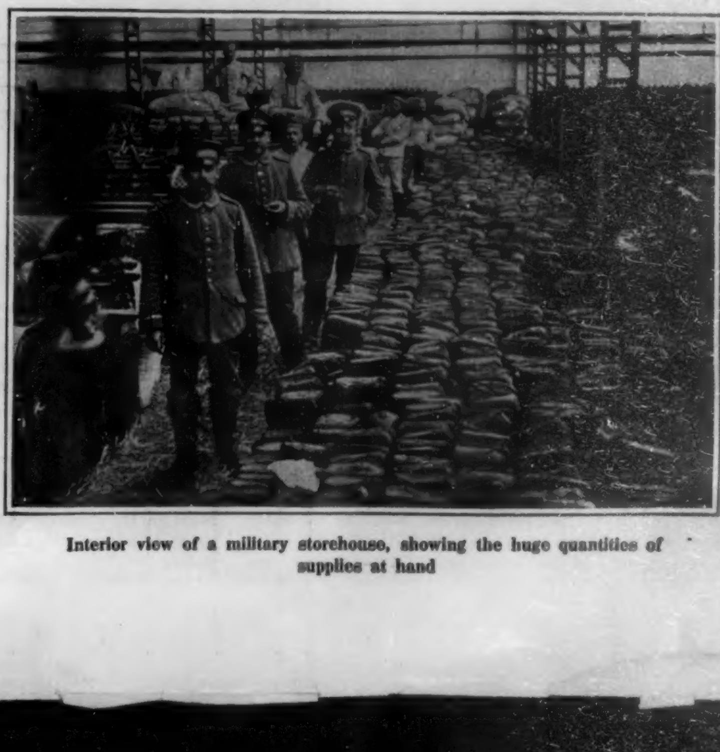
After this hammer strikes, it rebounds to a height depending upon the hardness of the steel, and as there is a definite relation between the hardness and strength, the graduated scale of the instrument indicates approximately what the strength is.

Potash Mines in Alsace

WITHIN a recent period, steps have been taken to operate the potash mines which were discovered in 1904 in the basin of Mulhouse. At the present time, one of the operating companies has a concession of 15,000 acres and is now working five shafts here. It is estimated that the total amount of product for the Alsatian region is no less than 300,000,000 tons, evaluated in potassium oxide (K_2O). Several different companies are now engaged in industrial operations in the district, the most important plant being the above mentioned one in the region of Mulhouse. In this case, the work first encountered a stratum of rock salt lying above the potash, which has about 8 feet thickness, while the potash strata are met with at a depth of 2,150 feet. This substance is sylvinite or chloride of potassium containing 30 to 44 per cent of the pure salt for the first stratum and 23 to 39 per cent for the second. Soundings on a large scale were first made in Wittelsheim forest in 1904, in which rock salt was found at 1,200 feet and strata of potash at 2,070 and 2,150 feet. This formation belongs to the oligocene period, and the geological data explain the method of formation. At first a basin existed here whose bottom was covered with soft water at the eocene period, then a sinking of the soil gave access to an arm of the sea in the oligocene epoch, as the sea then covered Belgium and part of France. This formed a natural evaporation basin with a narrow and often-barred channel, then came a new sinking of the soil, with irruption of the sea, then a gradual rise of the soil causing a separation from the sea. Thus fresh and sea water alternated here, resulting in various deposits down to the end of the tertiary epoch, according to surveys by German scientists.



One of the numerous field post offices near the front, for the receipt and distribution of mail



Interior view of a military storehouse, showing the huge quantities of supplies at hand

Panoramic Sight for Guns

THE panoramic sight is a special form of telescope which enables the user to look to the front, rear, or either side; in fact, to any quarter of the horizon without changing the position of his eye and to see erect images of the objects in view. An application of present interest is the use of such sights with field guns in firing at objects that cannot be seen from the gun. For example, should it be known that the gun in Fig. 3 is on a straight line joining the target and a tree in rear of the gun, the movable head *A* of the panoramic sight could be turned directly to the rear, and the gunner looking into the fixed eyepiece *B* would know that when he was sighted on the tree his gun was pointing at the target. The tree could be in any position so long as the angle at the gun between the target and the tree were known in order that the head could be turned the proper amount.

The general construction is indicated in Fig. 2. Should only the reflecting prisms at 1 and 2 be used, and all other optical parts be omitted, an object would appear upright when looking to the front, inverted when looking to the rear and on its side when looking to the right or the left. This may be readily demonstrated by holding two hand mirrors in the proper relative positions. With the objective lens 3, but not prism 4, added to the system the object would appear inverted when looking to the front and upright when looking to the rear.

The operation of the sight is dependent on the fact that if a prism of the form of 4 be rotated about its longitudinal axis, the image will rotate twice as fast as the prism. Should a person hold such a prism in his hand so that an erect image were seen, and then rotate the prism 90 deg., the object would appear completely inverted or to have rotated 180 deg.

In the case of the two reflecting prisms the image rotates as fast as the movable prism; that is the head has to be turned completely to the rear before objects appear fully inverted, but turning prism 4 90 deg. also completely inverts the object, and therefore by constructing the instrument so that prism 4 rotates with one half of the velocity of the head, the two inversions neutralize each other and an erect image is seen.

The rays of light when looking toward the front are indicated by Fig. 1. In this case the image is inverted by prism 4 and erected by objective 3. The image is reversed from right to left by objective 3, and the reversal is corrected by cross reflection from the lower inclined surfaces of prism 2.

Fig. 2 shows the path of the rays when looking toward the rear. The image in this case is still inverted by the objective 3, but not by prism 4, which is now rotated 90 deg. from the position shown in Fig. 1. The inversion is corrected by double reflection from prisms 1 and 2. The image is reversed by prisms 1 and 2 acting as simple reflectors, by objective 3, by prism 4, and by cross reflection from the lower inclined surfaces of prism 2. The net effect of these four reversals is that there is no apparent reversal, and the object has its normal appearance.

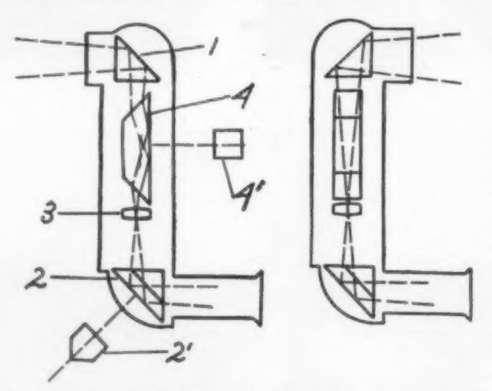
A similar analysis of any intermediate position of the revolving head will show that the object will always be seen in its true position.

American Motorcycles for the European Fighting Men

ONE of the characteristic features of modern warfare is the use of the motorcycle in place of the horse by dispatch carriers and others. Although motor cars are being employed, to a great extent, for military purposes, there are conditions under which they must give way to the motorcycle. The light weight and great power of the latter become paramount considerations when roads are rough and muddy, and when transportation accommodations for only one or two passengers are required.

The uses to which the motorcycle has been put, aside from the carrying of dispatches, are manifold. It has been found an ideal means of transporting officers from one point to another in a short space of time; in fact, the motorcycles can make a greater speed than the average automobile, with a greater degree of safety. The two-wheeled motor vehicle has also been found indispensable for rapidly reaching different sections of a long supply train on the move; for on such a mount an officer can cover several miles in the minimum space of time and thus keep in touch with every unit and man of the entire train. Where roads are poor and even where they become mere foot paths, the motorcycle can be used.

There has been experienced on the part of the military drivers the tendency of motorcycles to skid when traveling at high speeds over muddy roads. To overcome this danger, many of the military machines now in use are provided with standard side cars, which greatly reduces skidding while not reducing the speed to an appreciable degree. In the accompanying illustration are seen a number of American motorcycles now being used by the motor truck division of the Spanish army. It will be noted that, in conformance with the latest lessons of the European war, these machines are provided with side cars.



Figs. 1 and 2—Principal optical features of panoramic sight and path of light rays when looking to the front and when looking to the rear

The parts shown in Fig. 1 are: 1.—Reflecting prism mounted in movable head, which can be turned horizontally in any direction. 2.—Fixed reflecting prism. 2'.—Cross section of 2. 3.—Objective lens. 4.—Prism rotating with one half the angular velocity of the head. 4'.—Cross section of 4.

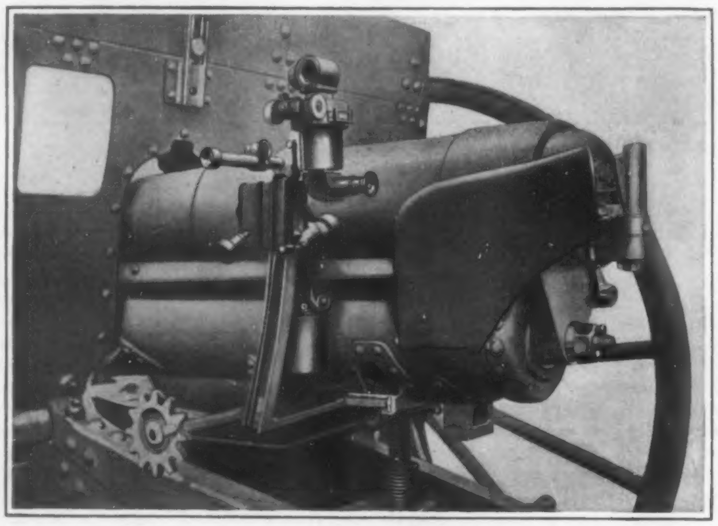
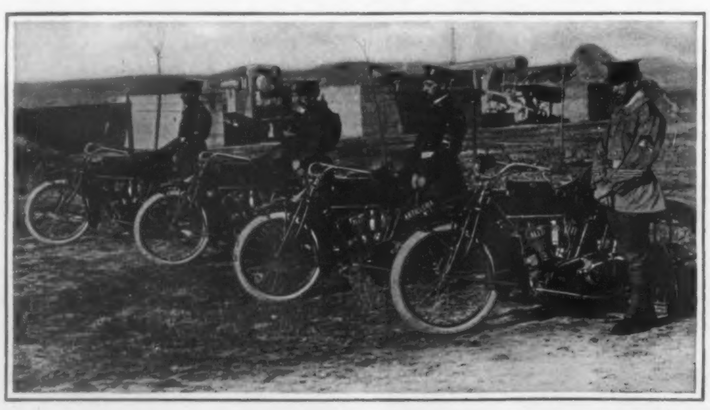


Fig. 3—Panoramic sight on a modern field gun carriage



American motorcycles with side cars used by the automobile truck division of the Spanish army

The Fur Seals of the Pribilof Islands

THERE are in existence only two important herds of fur seals, one of which has its breeding grounds in the Commander Islands, belonging to Russia, the other in the Pribilof Islands, belonging to the United States. Of these the latter is much the larger. The Pribilof Islands are Government property, and thus it happens that the United States Government finds itself the owner of by far the most valuable herd of fur seals in the world. This unique bit of property has been a source of much tribulation—as everybody knows.

Fur seals are, to all intents and purposes, domestic animals. The herd returns year after year to the same breeding ground; indeed, the "bulls" most frequently choose a particular spot on the beach during their first breeding season and occupy it, with their "harems," ever afterward, during the months they spend ashore. At this period the herd is entirely at the disposal of man; the animals may be driven up, counted, caught, examined, branded or killed even more easily than range cattle. Thus the control of the herd is a comparatively simple matter, provided the animals are immune from destruction by man during periods of absence from the breeding ground—*i.e.*, when feeding or engaged in their annual migration—and this immunity was secured by the treaty abolishing pelagic sealing, effective December 15th, 1911.

This treaty, however, which was to run for 15 years, did not terminate the interest of other nations in the Pribilof seal herd. To compensate them for giving up the privilege of pelagic sealing the United States pays to Great Britain and Japan 15 per cent of the profits of land sealing at the Pribilof Islands, and a similar payment is made by Russia in connection with the seals under her control.

These facts explain the large amount of attention that has been devoted to a biological problem connected with a small group of rocky islands in the midst of Bering Sea.

The latest of the many scientific commissions that have visited these islands, under official auspices, for the purpose of investigating the seal herd has recently rendered its report.[1] On August 24th, 1912, Congress passed a law prohibiting all killing of fur seals on the islands for a period of five years, except the number needed as food for the natives, and providing for a breeding reserve of not less than 5,000 3-year-old males annually during the life of the treaty suspending pelagic sealing. In order to ascertain the effect of these measures, and to help settle various points in dispute as to the future regulation of the herd, the Department of Commerce decided to send to the islands a commission of three experts who should be free from previous interest in the fur-seal controversy and therefore unprejudiced. Accordingly the president of the National Academy of Sciences, the secretary of the Smithsonian Institution, and the Secretary of Agriculture were requested to make nominations. Their nominees, all of whom accepted appointment, were, respectively, Prof. George H. Parker, Wilfred H. Osgood, and Edward A. Preble. They spent the summer of 1914 at the Pribilof Islands, and were accompanied by two representatives of the Canadian government and one of the Japanese government.

While it is impossible to summarize here the voluminous report of these experts—dealing, as it does, not only with the seals, but with the animal life of the islands generally—two of their most important conclusions may be noted. One is that the fur seal is by no means, as has been popularly supposed, on the verge of extermination. The other is that no justification exists for the present closed season. Commercial sealing, under proper restrictions, should be resumed at once.

The herd now contains approximately 294,000 individuals, of which not less than 93,250 are bearing females.

Earth Shocks Due to Frost Cracks

IN the annual lists of earthquakes registered at the Harvard Seismographic Station occasional shocks occurring in winter are noted as due to "frost cracks;" *i. e.*, the sudden opening of fissures in the ground resulting from freezing. Prof. Woodworth, director of the station, states that the late Prof. Shaler, in one of his lectures, mentioned the occurrence of a sensible shock at Cambridge some forty years ago, which he traced to a crack in the frozen ground. An apparent earthquake near Akron, O., probably due to a frost crack, was described in the *American Geologist*, vol. 1, 1888, p. 190-192, while another, which caused a mild panic at Attleboro, Mass., was reported in the *Attleboro Sun* of January 23rd, 1903. Prof. Woodworth says that "this idea of frost cracks is very widespread in New England as an explanation of many small shocks coming at a time when the frozen ground is known to have cracked open."

[1] The Fur Seals and Other Life of the Pribilof Islands, Alaska, in 1914. From the Bulletin of the Bureau of Fisheries, Vol. XXXIV. Issued June 19th, 1915.

What Is a Comet's Tail?

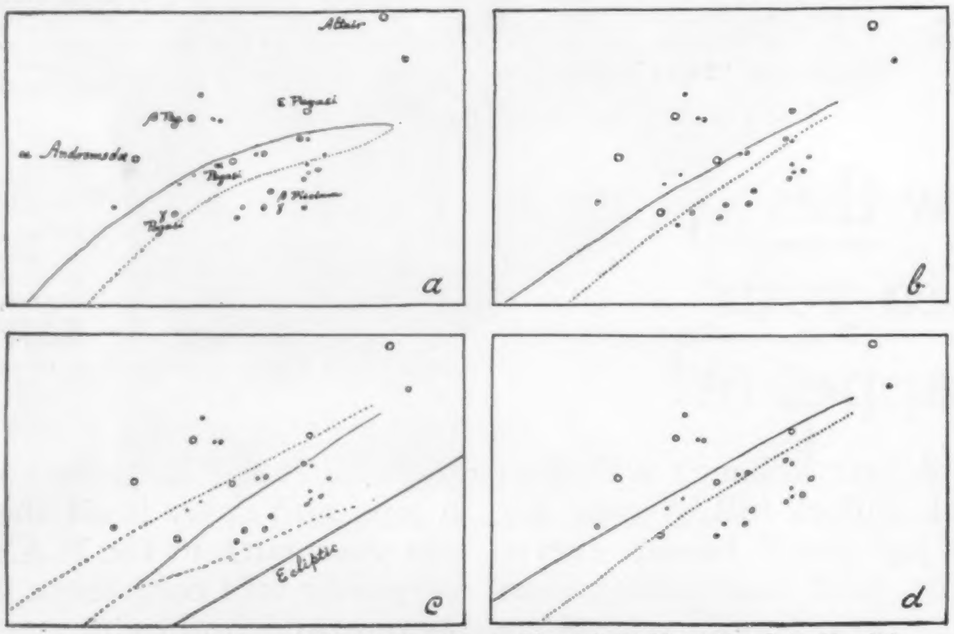
Some New Results from the Recent Appearance of Halley's Comet

By Frank W. Very

MOST of the readers of the SCIENTIFIC AMERICAN presumably looked at Halley's comet when, in the latter part of May, 1910, it appeared night after night in the western sky; but if they did not, few of them will be likely to live to see it return, since that will not happen for about 70 years. Few, however, were probably enterprising enough to get up at 3 A.M. on the mornings of May 17th to 19th, 1910, when the comet was rapidly approaching the line joining sun and earth, but before its supposed, though unobserved transit across the sun's face. On those mornings, its immensely long, and straight tail stretched, like the beam of a great searchlight, obliquely from the eastern horizon nearly to the Milky Way; and it was certainly one of the most impressive spectacles that the writer has ever seen. The swiveling of the tail between these dates, as seen from our position in space, is of some interest in respect to the question whether the earth actually passed through the tail. The comet's tail certainly approached very near to that imaginary line among the stars which defines the intersection of the plane of the earth's orbit with the celestial sphere, and at a time when the nucleus was almost in line with the sun, and then receded. If the extension of the tail was great enough, and its pointing true enough, its most attenuated tip may have touched the earth for a brief interval. There can be no difficulty in respect to extension. Prof. Barnard made the length of the tail at this time "at least 120 deg." The writer's eye-estimate was 115 deg., according to which the extension was far beyond the earth's orbit. This was also suggested by the steady tapering of the luminous beam towards the tip, assuming that this represented, at any rate, a very definite branch of the tail. There can scarcely be a doubt that this was an effect of perspective, and that we were viewing an approximately cylindrical shaft of light, narrowing as it vanished into the distance. The writer made the breadth of the tail at its widest part 5 deg. on the morning of the 18th (civil), and the next morning, when we were still nearer, Barnard found the breadth 10 deg. After passing over a dark gap on the lower (southern side of the tail), an exceedingly faint, diffuse luminous haze was noticed by Barnard, which stretched on either side of the ecliptic trace, and to the horizon. This may have been a second, still nearer branch of the tail, at least 20 deg. broad. In agreement with this view, my notes make the south border of the upper branch very diffuse, as if there were more to come on that side.

Many observers in different parts of the earth witnessed halos and coronas of exceptional brilliancy about either sun or moon on the 19th of May at the time or soon after the time of closest approach. At the Yerkes Observatory, Prof. Frost noted irridescent clouds of remarkable brightness from noon until 1 P.M., and the unusual phenomenon of a halo of 15 deg. radius. Prof. Max Wolf, of the Königstuhl Observatory, reported a twilight of long duration and exceptional intensity with three successive purple twilight glows, and a "Bishop's ring" about the moon, more intense than any he had ever seen, of a diameter of 56 deg., which indicated the presence in the atmosphere of vast numbers of particles, one and a half thousandths of a millimeter (about six one-hundred thousandths of an inch) in diameter. Many observers noted the ordinary solar halo, 45 deg. in diameter, and due to ice crystals, which is fairly common; but these crystals might, in this instance, have been condensed on cosmic dust. The Bishop's ring and twilight glows are rare phenomena, commonly associated with the presence in the upper air, of excessively comminuted dust from volcanic eruptions. None of these appearances are so entirely exceptional that they might not have been earth-born, and yet their presence at just this time strongly suggests a cosmic origin. If this is a fact, we are at liberty to surmise that some of the light from a comet's tail is reflected from dust particles, originally thrown off by explosive eruptions from a cometary nucleus which, even if it be only a few miles in diameter, must become heated to incandescence under the sun's rays beneath a highly absorbent atmosphere of carbonaceous gases. Brilliant jets, which are probably eruptions of dust-laden gas, are frequently seen to issue from the nucleus of a great comet and expand into the coma. Some of this dust must be highly electrified and, if so, may be electrically repelled into the tail where it is seized by other forces, namely, those of the pressure which sunlight exerts on exceedingly fine particles. By the pressure of sunlight, the dust is then sent spinning into space. This, at least, is the supposition. We shall see how it has been brought to the test when applied to this comet.

Halley's comet, May 5th, 1910, photographed at the Lowell Observatory, Flagstaff, Arizona



Tail of Halley's comet at 3 A. M. (*a*) May 17th, (*b*) May 18th, (*c*) May 19th and (*d*) May 20th (*a*, *b* and *d* drawn by Very, *c* after Barnard)

Spectrum of the tail of Halley's comet photographed with an objective prism, without any slit, May 10th, 1910, at the Lowell Observatory, Flagstaff, Arizona

We next appeal to the spectroscope, and find that the head of Halley's comet gave out considerable light having a continuous spectrum, that is, one in which every color of the rainbow is present in a graduated series. Such a spectrum might be produced with light emitted by incandescent dust, or if rich in blue and violet light, it is more likely to represent nothing but sunlight reflected from cooler, but solid, rather than gaseous material. In fact, this criterion of the presence of violet and even of ultra-violet light, as well as the observation of the stronger dark Fraunhofer lines of the solar spectrum, definitely decides that there was a considerable admixture of sunlight in the light from the comet's head. Farther away from the head, however, during most of the comet's shining, this continuous spectrum became much fainter and at length was too feeble to affect the photographic plate. Whatever solid dust there was in the extension of the tail at such times, reflected much less light than was given out by another self-luminous constituent. But even if there were not dust, this would not necessarily prevent dust effects in our atmosphere, because swiftly moving molecules, or electrically dissipated cathode or anode particles of smaller dimensions than molecules and too fine to reflect sunlight, might serve as nuclei of condensation on entering the atmosphere. Upon these nuclei, minute ice crystals could be built up. The process and the resistance of the air would soon slow down the enlarged particles, leaving them to hang suspended in air for a while as halo-forming dust.

We next ask what the spectroscope has to say in regard to the presence of molecules in the comet's tail, for if these are present, the spectrum should be one of discontinuous colored bands; and here I may refer to some beautiful, objective-prism spectrograms of Halley's comet taken on isochromatic plates at the Lowell Observatory. No slit whatever was used at the usual slit end of a collimator, as in the ordinary spectroscope; but instead, the image of the comet was formed directly by a telescope whose objective was covered by a large prism. The image itself was then virtually its own bright slit, and this image was multiplied by the prism as many times as there were different sorts of light. This was possible in the present instance, because the light of this comet's tail through a considerable part of its career, and unlike that of its head, consisted mainly of only a few special, colored rays, principally of blue and green light; and these formed as many separate images of the tail, complete in every detail, each a duplicate of the others, but in a different part of the spectrum. There were not enough images, nor too closely spaced, to spoil the picture by overlapping. These successive images impressed upon the photographic plate, where their positions and consequent wave-lengths of the luminous rays could be accurately measured, conveyed the following important information:

On May 29th, at a distance of 3 to 6 deg. from the head, there was found in the light of the tail 80 per cent of emission bands due to carbon monoxide (a gas whose molecules are composed of one atom of carbon united to one atom of oxygen), and 20 per cent of continuous spectrum. "From April 29th to May 7th," says Dr. Lowell, "the tail spectrum was almost wholly

(*Concluded on page 160.*)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CENTRAL STATION AND ISOLATED LIGHTING AND POWER PLANTS
SUBMARINES MOTOR BOATS YACHT LIGHTING
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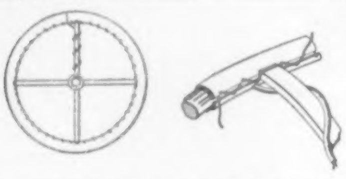
RECENTLY PATENTED INVENTIONS

These columns are open to all patentees. The notices are inserted by special arrangement with the inventors. Terms on application to the Advertising Department of the SCIENTIFIC AMERICAN.

Electrical Devices

ELECTRIC HEATER FOR STEERING WHEELS.—G. H. BARNES, Stanbridge East R. M. D., No. 3, P. Quebec, Canada. This invention provides a heating means which may be readily attached to the steering wheel of automobiles, motorboats, aeroplanes, and the like, without the necessity of dismantling the



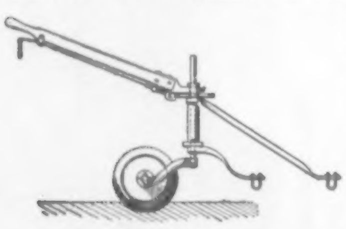
ELECTRIC HEATER FOR STEERING WHEELS.

wheel in any way or of boring or otherwise mutilating it. The invention avoids the necessity of using brushes or movable contacts. The heating medium also serves as an efficient gripping member for the wheel thus preventing the hands from slipping.

Of Interest to Farmers.

MILKING STOOL.—L. H. CHASE, 232 Fillmore St., Denver, Colo. This invention provides a stool, formed of metal for the major portion to give the requisite strength and permit of thorough cleaning of the stool when desired; provides a stool so formed that a flaring milk pail may be placed in proper and convenient relation to the stool when milking; provides a stool having means for the support of a water pan whereby to wash the cow's udder; and provides a support for heating the water when desired.

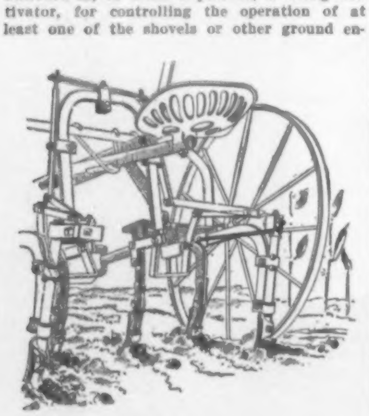
STEERING DEVICE.—N. P. NELSON, Newberg, Ore. The invention has particular reference to a reversible handle for steering devices. It provides a device which may be employed in connection with any character of machine, such as seed planters and other



STEERING DEVICE.

agricultural machines and the like, the device including a caster-wheel having a spindle extending through a bearing provided with a toothed plate adapted to be engaged by an adjustable part of the handle whereby the latter may be releasably held in any adjusted position.

CULTIVATOR.—A. J. KIEFFER, Nevada, Ohio. This invention provides a cultivator attachment in the nature of a device to be attached to, or made a part of, a riding cultivator, for controlling the operation of at least one of the shovels or other ground en-



CULTIVATOR

gaging tool, in such manner that these shovels or tools may be shifted to lie at an angle with the direction of travel of the cultivator, so that, as the latter moves along, the shovel gangs will be moved to the right or left, as the case may be, by the action of the ground against the shovel or tool, in order to avoid cutting or uprooting the plants being treated.

Of General Interest

METALLIC PACKING.—R. H. ALDRICH, Allentown, Pa. The object here is to provide an efficient packing which is characterized by the provision of a metallic, yieldable ring, which carries a resilient member adapted to contract the metallic ring when pressure is applied to the said metallic ring.

MEANS FOR LABELING RADIOGRAPHS.—A. DE YOANNA, 565 Henry St., Brooklyn, New York, N. Y. This invention relates to a means for labeling X-ray photographs, commonly known as radiographs, and has for an object the production of a label forming part of the picture. It provides a label for a radiograph which forms part of the picture and which may contain any desired information and may be arranged so as to appear on any part of the negative.

BUTTER MOLD.—R. J. COSSEBOON, Buena Vista, Colo. One of the objects of the invention is the provision of a mold consisting of hinged sides and ends having pivoted clamps for retaining them in closed position, a press block being vertically movable between said sides and ends and detachably carried by an adjustable operating rod.

Hardware and Tools

DETACHABLE COMBINATION LOCK.—G. T. OLDHAM, 74 Cortlandt St., New York, N. Y. This improvement has for its object to provide a detachable combination lock having a shank with a lateral shaft for disposal in an opening in a key plate, a "combination" locking device being mounted on the shank for cooperating with teeth on the edge of the shaft.

WELL TILE PLACING TOOL.—G. H. CARGIN, Marcus, Iowa. This invention relates to a tool for placing well tiles in position, one on top of another. An object is to provide means for locking the tile gripping elements in gripping position and in conjunction therewith an automatic device for unlocking the said locking means so that the tool will be released from the tile.

Heating and Lighting

FUEL SAVER.—J. MANDEL, 2139 Lexington Ave., New York, N. Y. The invention provides a sort of drum construction to take the place of a section or joint of stove pipe or furnace flue, the same being provided with means automatically operated by the draft created upwardly in the pipe or flue, to cause a certain amount of downward pressure or draft of fresh air which, combining with the gases tending to escape, will create a condition of uniform draft and nearly perfect and complete combustion.

Household Utilities

COFFEE AND TEA STRAINER.—H. N. NEWLIN, 614 Bainbridge St., Brooklyn, New York, N. Y. This invention relates to improvements in straining devices, and particularly to a coffee and tea strainer, and has for an object to provide an improved structure which may be readily applied, and which may be readily assembled and disassembled.

CURTAIN ROD.—P. ALTSCHUL, 9 E. 49th St., New York, N. Y. The object here is to provide a curtain rod which is hingedly mounted on the window frame at one end and is releasedly fastened with respect to the window at the opposite end, whereby the curtain can be swung bodily outwardly away from the window frame for various purposes, as cleaning the window panes, hanging the shade, etc.

DRAIN COVER.—D. J. CONNELL, 412 North Washington St., Butte, Mont. This invention relates to drains, as in kitchen drains, and main object thereof is to provide a readily applied and as readily removable cover therefor which will enable a housewife to use the sink for washing dishes, clothes, and the like, to avoid the necessity for using an unsatisfactory dishpan, or for carrying sufficient hot water to a washtub to use the latter.

Machines and Mechanical Devices

SAFETY CLUTCH FOR FEED CUTTERS.—M. A. PAULSON and C. FREDERICKSON. Address the former, Rice Lake, Wis. The invention relates to clutches, and the main object thereof is to provide such devices which are applicable to feed cutters whereby the cutters may be stopped, as by a hard substance in the feed being cut, without affecting the operation of the mechanism for actuating said cutters.

METHOD AND APPARATUS FOR DEFIBRATING FIBROUS VEGETABLE MATERIALS.—G. J. MAHIEU, Caix 221, Rio de Janeiro, Brazil. The invention relates to the removal or extraction of fiber from various vegetable material containing the same, and to cleaning all such fiber in order that the latter may be used in various arts. The invention avoids severity of action upon the fibers during the process of separating other vegetable material therefrom.

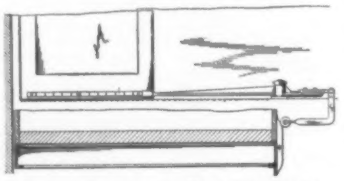
FLEXIBLE DRIVE MOUNTING.—M. S. YOUNG, 1392 Iroquois Ave., Detroit, Mich. This invention provides a drive mounting which will constitute a support for the drive wherein the drive can be displaced to obtain the tightening of the flexible transmission member without any disturbance of the parallelism of said drive with reference to the mechanism driven therefrom.

MACHINE FOR STRIPPING, DYEING, AND WASHING SILK.—G. A. CARSON, 156 Preakness Ave., Paterson, N. J. This invention relates to machinery for treating fabrics and has particular reference to means for treating skeins of thread, yarn or the like. The invention provides a means for rapidly and economically operating upon skeins of raw silk.

YIELDING COUPLING.—E. H. SIMONS and R. KLEIN, Weinheim, Germany. In this invention the power transmission is obtained by means of blade springs, the latter being connected to one coupling member and bearing upon the faces of the other coupling member. In constructions of couplings of this kind the blade springs bear upon the driven face of a coupling member not at right angles to the direction of the peripheral force and possess the drawbacks that the springs are influenced by lateral forces which result in rapid wear and even fracture of the coupling. These couplings are not suitable for transmitting high power. The present invention eliminates this drawback.

FOUNTAIN BRUSH.—H. REICHE, South Somerville, N. J. This invention relates to certain improvements in devices for mechanically treating surfaces, and also for applying thereto a liquid or solid substance. The device consists primarily of a brush which is connected to a handle inclosed means for operating the brush and delivering thereto the treating material.

SAFETY LATCH FOR ELEVATOR DOORS.—C. O. MARX, 194 Crystal St., Brooklyn, N. Y. This invention has particular reference to latch means arranged to be tripped by the car to permit the door to be manually opened



SAFETY LATCH FOR ELEVATOR DOORS.

or closed by the elevator attendant and to cause the automatic latching of the door at the interior as the car starts away from the landing in either direction.

Musical Instruments

STRINGED MUSICAL INSTRUMENT.—N. R. BOSWELL and E. D. WILBER, 601 Hodges Bldg., Detroit, Mich. The improvement provides a musical instrument arranged to enable the beginner to learn to play the instrument in a comparatively short time. This is accomplished by providing a movable finger adapted to produce chords when placed upon the strings at certain places.

Prime Movers and Their Accessories

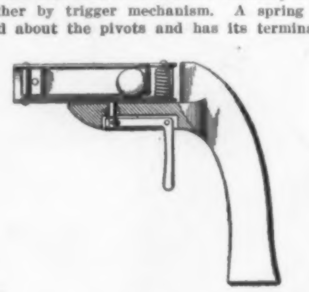
FUEL VAPORIZING DEVICE FOR INTERNAL COMBUSTION ENGINES.—L. B. WHITE, Manson, N. C. The improvement provides a device by means of which kerosene or other heavy oils which are not so volatile as the lighter oils, such as gasoline can be used successfully in internal combustion engines. It provides a device by means of which the heat of the exhaust, which is ordinarily wasted is utilized for heating a liquid fuel to its vaporizing temperature.

IGNITION SYSTEM FOR INTERNAL COMBUSTION ENGINES.—H. C. WELL, Room 1201, 110 W. 140th St., New York, N. Y. This improvement provides a system having a rotatable means for closing an open circuit connected with the spark plug of the engine. It also provides driving means for the rotatable means, which is operated by the piston rod of the engine.

COOLING SYSTEM.—E. P. CULVER, care of Peck Coal Co., Portchester, N. Y. This improvement is characterized by the combination of the thermosiphon system of cooling with the force system of cooling. It provides a cooling system for internal combustion engines, which system will require but a small volume of cooling medium and consequently will be of small capacity, although the engine will be perfectly cooled.

Pertaining to Recreation

TOY GUN.—O. W. MALONEY, Box 486, Tulsa, Okla. The invention comprises a stock to which are secured a pair of pivoted members, the free ends of which are normally held together by trigger mechanism. A spring is coiled about the pivots and has its terminals



TOY GUN.

engaging the free ends of said members so that when the trigger mechanism is actuated the members are forcibly spread apart and operate to eject a projectile from a propelling device secured to the members adjacent the free ends thereof.

AUTOMATON.—R. J. SCHUHMANN, 4823 South 3rd St., Louisville, Ky. This improvement provides a device with means for moving the same incidental to and in correspondence with the action of a vehicle; and provides means for moving certain portions of the automaton in simulation of the movement of a human figure, to produce an amusing and interesting impression on the observer.

CAROUSEL.—W. F. MANGELS, Coney Island, New York, N. Y. This invention relates more particularly to a carousel of the portable or knock-down type. It provides a novel column structure and mounting therefor whereby the column can be easily and quickly put up or taken down, and whereby the column will be strongly and rigidly braced.

TOY PISTOL.—L. S. BIXLER, care of Kenton Hardware Co., Kenton, Ohio. This invention provides a toy pistol having an anvil within the pistol casing with a recess in the casing in front of the anvil so that a projection on the hammer will be disposed over the anvil and in the recess when the hammer is seated on the anvil, to prevent sparks from flying when a cap is exploded against the anvil. The hammer is constructed to form a continuation of the upper surface of the casing when the hammer is seated against the anvil.

GAME APPARATUS.—L. M. KRANER, Cloverdale, Ore. The primary object here is to provide a game of skill that may be played by parties of both sexes either indoors or out, whereby to furnish amusement and moderate exercise for the body without running or stopping, thus affording wholesome recreation and pleasure.

COMBINED FLYING AND SPINNING TOP.—B. E. LLOYD, 257 8th St., New York, N. Y. This invention relates more particularly to flying and spinning tops of that type in which the flying element is given a high rotative speed by being moved quickly along a screw and finally thrown off the same, whereby the said element will fly through the air and ultimately light on the ground, floor or other surface and spin until its force is expended.

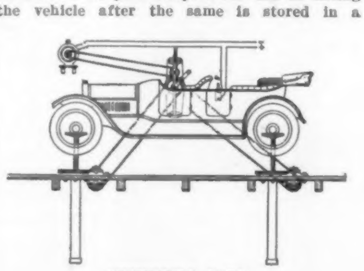
Pertaining to Vehicles

MOTOR VEHICLE SPEED CONTROLLER.—T. DOUGLAS, 80 Maiden Lane, New York, N. Y. The present invention relates to motor vehicle controllers particularly suitable to motor vehicles propelled by internal combustion engines and especially to those controllers which are designed to control the maximum travel speed of the vehicle to a speed proportionate to the load carried by the vehicle.

BLOWER FOR SIGNALING DEVICES.—NELSON NYBERG, 420 San Antonio St., El Paso, Tex. In the present patent the blower consists of a seat having upper and lower compartments divided by a partition having a valve opening, with which a valve coöperates, there being springs for holding the top of the upper compartment extending upwardly, so that as the occupant of the seat is moved up and down by the unevenness of the road, air will be drawn in through valves in the bottom of the lower compartments and this air will pass through the valve opening in the partition of the upper compartment, where it will be compressed to be fed through a pipe to a pneumatic signal controlled by a valve in the pipe.

AUTOMOBILE CRANKER.—J. D. WELLIVER, Milford, Pa. Among the principal objects of the invention is to provide a mechanical cranking device adapted to be easily, quickly and reliably attached to the ordinary mechanism of an automobile motor which may be operated by the driver of the car while seated in his place.

AUTOMOBILE JACK.—C. E. DAVIDSON, Ozona, Tex. This invention relates to a hoisting apparatus, and more particularly to an automobile jack adapted for use in lifting the vehicle after the same is stored in a



AUTOMOBILE JACK.

garage, whereby a constant pressure on the tires will be avoided and the making of necessary repairs facilitated. The invention comprises a plurality of casings mounted in and extending below the flooring of the garage, each of said casings having a lifting member in the form of a screw spindle vertically movable therein.

Designs

DESIGN FOR A DOLL OR STATUETTE.—R. S. ILSLEY, 10143 101st St., Edmonton, Alberta, Canada. The head of the doll has long flowing hair, with an aquiline nose, long eyebrows, and a long beard extending from the chin, the body being nude, with a slightly extending abdomen and with prominent toes.

NOTE.—Copies of any of these patents will be furnished by the SCIENTIFIC AMERICAN for ten cents each. Please state the name of the patentee, title of the invention, and date of this paper.

What Is a Comet's Tail?

(*Concluded from page 156*)

emissive [that is, composed of bands due to light *emitted* from glowing gas]. On May 11th it had changed to one nearly continuous [or, as explained above, the light was sunlight reflected from dust]. While on May 23rd it had become largely emissive again and grew more so as time went on." Thus, at the time when those portions of the tail were being thrown off which reached the position of the earth on May 19th, there was an unusual prevalence of dust in the cometary emanation, and to this extent, at any rate, there is evidence favoring the supposition that the atmospheric dust effects, if of cometary origin, may have been directly due to cometary particles, and not necessarily to secondary nuclear enlargements of an otherwise invisible molecular emanation. The gaseous tail was confined to rather narrow streamers which were often *bifurcated in a peculiar way.* The dust tail, always simultaneously present, even though it may have been the fainter of the two, which was practically the sole appendage from May 11th to May 23rd, 1910, had an entirely different shape from the gaseous tail. The dust tail was broader than the gaseous streamers and included them without sharing their structure. Its borders at some distance from the head were also diffuse, especially the southern border on the mornings of May 18th and 20th (civil date).

During a large part of the comet's appearance, strong ultra-violet bands were observed in its spectrum, produced by glowing cyanogen gas, a highly poisonous substance consisting of two atoms of carbon and two of nitrogen in one molecular union. This spectrum, however, though it became very strong in the latter part of May and early in June, never extended much beyond the limits of the coma, or head of the comet. Apparently, a high temperature was needed for its exhibition. The hydrocarbon spectrum also, which was very strong in the head, faded rapidly in the tail and was entirely lacking after the first half degree. But the spectrum of carbon monoxide, not noticeable near the nucleus, rapidly increased in intensity on passing into the tail and continued unabated to distances of many millions of miles from the head. Throughout its course, the excessively rarefied gas must have experienced the cold of space. What, then, can have been the process by which the light was produced. Can it have been of the nature of an auroral glow from a continuous electric discharge? Or is there enough attenuated oxygen gas in the interplanetary spaces to progressively consume the hydrocarbons as they pass through it, so that we are looking upon a multitude of tiny flames which appear continuous merely because they are innumerable, and which are continually disappearing to begin again at other widely separated points in space? We can not decide these questions offhand, and must wait for further information.

For a brief duration, the bright lines of sodium appeared intermittently in the spectrum of the head near the nucleus, especially on the hotter side toward the sun, showing that at these times the temperature of the nucleus must have been near enough to incandescence to disengage the vapor of this substance which, in the metallic form, distils at about 900 deg. Cent., but might be separated from some of its compounds at somewhat lower temperatures. This gives us a suggestion of the almost volcanic turmoil which must be going on at the nuclear surface. Under these circumstances, the solids of the nuclear surface become pasty. The gases in the pores of the solid material are then emitted, bubbling out as from the frothing pumice of a lava cone to form an atmosphere extending to a great distance, because the gravitational attraction of the central mass is too feeble to retain or condense such an atmosphere within a narrow compass. The gases are thus readily separated from the main body and are emitted in considerable quantity, at first towards the heat-producing sun; but eventually they turn backward in a direc-

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tion immediately opposite to the sun, though not always with complete regularity. There are fluctuations both in the length and the brightness of the tail, and these are probably connected with the thermal vicissitudes in the nucleus.

The path of the gaseous particles is a blend of their original orbital motion and a new and more rapid velocity imparted by the action of sunlight. This action, foreseen by Maxwell, but actually discovered by the Russian physicist, Lébédeff, and applied to explain the formation of comet's tails by our own Nichols and Hull, is a sunlight pressure whose effect becomes very great when the masses of the particles are small and their dimensions approach molecular size. The particles are then repelled at so great a speed that they reach the utmost limits of the tail in a very few days, and then cease to glow, either because they are no longer incandescent, or are consumed, or possibly because they are so widely separated that they no longer conduct electricity. The tail seen at any one time is therefore not the same tail that is witnessed some days later. The latter is a wholly new formation. This was well shown when, on the evening of May 20th, the head of the comet having passed between us and the sun (or from the morning, or western elongation, to its evening, or eastern elongation), was seen by Barnard in the west one half deg. in diameter, the nucleus like a yellow, nebulous, second-magnitude star, and its spectrum was photographed by Slipher, but with not enough tail to be certain of it. Remnants of the huge 120-deg. tail were still visible in the morning sky, but the new tail which was to be seen in the evening on later dates, had not yet formed.

In order to confirm the hypothesis that the velocity of particles in the tail is truly produced by the pressure of light, it was highly desirable to measure this velocity. Dr. Lowell, having at his command some 200 photographs of Halley's comet, taken at his observatory between April 18th and June 6th, 1910, set himself the task of detecting a sufficient number of knots, or observable irregularities in the tail, to be able, by timing their progressions, to deduce a series of values for the linear velocity of a particle at different distances from the nucleus. If the light-pressure in question is really acting, it should give a continually increasing velocity as the particle recedes from the nucleus. If, on the contrary, the original velocity has been given by some impulse, and there is no light-pressure, the solar attraction will continually retard the motion. The following observation, which was made by Dr. Lowell on the evening of May 23, 1910, definitely decides in favor of the light-pressure theory:

Tail of Halley's Comet.

	Angular distance from the nucleus to the point measured in the tail	Velocity of the point of the tail away from the nucleus.
Knot 1......	1° 28′	13.6 miles a second
Knot 2......	3° 12′	17.2 " " "
Knot 3......	4° 36′	19.7 " " "
Knot 4......	6° 15′	29.7 " " "

The result is given in its original tabular form, because it seems to the writer that the figures are more impressive than any description which he could offer. The swiftest velocity amounts to over 2,500,000 miles in one day. Similar, but slightly greater velocities were obtained by Prof. Barnard for a different knot on June 6th, 1910, completely confirming Dr. Lowell's measurement as to the fact of accelerated motion. That the increment of the velocity is not perfectly regular, is due in part to the difficulty of identifying the precise center of a vaguely defined knot. But in part such variations are presumably due to collisions between rival masses, and were to be anticipated. The very forms of the knots suggest local disturbances and whirling masses.

Another fact of very great importance appears when the observation is connected with further information given by the spectrograms. A simultaneous photograph of the spectrum of the tail, made by Dr. Slipher, showed that the tail was composed mainly of gases, on this date. The spectrum was almost wholly a band spectrum. Consequently the particles whose motion was viewed in the aggregate, were free molecules, and not particles of solid dust. Thus was settled in the most positive manner, the dispute as to whether molecules do, or do not share in the repulsion which light had been shown to exert upon solid dust particles. We now know that the molecules are certainly moving after the manner called for by the theory of sunlight pressure. The absorption of light by a free gaseous molecule is selective. Only a few rays of special wave-lengths are absorbed. Nevertheless, though only a fraction of the sunlight is effective, the mass to be moved is so small that a large velocity can be generated. And so far as one can see, this motion of recession under pressure of light from the sun must continue until the far-away sun is only a star among the heavenly host, and its particular light-pressure is annulled by that of other stars, and comparative quiescence results under the influence of the general stellar complex.

The Potash Famine

(*Concluded from page 146*)

What will be the economic effect upon the states of our Atlantic seaboard during 1916, as the wonted potash ration is lacking for their cotton, corn, potato, and tobacco fields, for the intensive culture of their thousands of truck gardens? Farmers and gardeners will furnish the customary supplies of combined nitrogen and phosphates, as they plow, and seed, and till. They will perform the same amount of labor, pay the same amount of taxes, or the same rental. And yet, every intelligent southern planter knows that when he formerly harvested 10 bales of cotton, he may this year have but 8 bales as a return for his labors; where he usually gathered 23 bushels of beans per acre, he will now gain but 14 bushels; where he ordinarily harvested 75 bushels of corn per acre, he can now hope for but 32 bushels.

It would not be a complicated problem in mathematics to calculate roughly what will be the economic loss during the present year, in any given state, such as Florida or South Carolina, resultant upon the absence of the normal potash ration.

We are now taking stock in many branches of the nation's industrial activity. On every side the dominant notes are: "Emancipation from Dependence Upon Foreign Products!" "Creation of Self-Contained, Comprehensive, American Industries!" "Utilization of Our Natural Resources!"

What is the bearing of this newly awakened spirit of industrial independence upon the potash situation? Is there a possibility of temporary relief? Is there a prospect of permanent freedom from dependence upon Transatlantic sources?

To answer these questions intelligently we must know the nature of the part supply of potash salts. We must further consider to what extent such salts are present in the mineral wealth of our land. Finally, we must note the steps requisite for their economic utilization.

Sources of Potash

Hitherto our domestic supply of potash compounds has come almost exclusively from Germany, directly or indirectly. There was a small import of saltpeter from India, and of carbonate of potash from Siberia, Turkey, and several European countries. Otherwise, in common with the rest of the civilized world, we depended upon the famous mines of Stassfurt in Germany.

It was about 1860 that the importance of potash in agriculture, became generally known, thanks to the investigations and to the brilliant pleading of Liebig. The old-time source of potash, the ash heap of the pioneer and of the inhabitant of richly forested regions, was fast disappearing. A few years before, the marvelous deposits of various potash salts in the Harz Mountains were discovered. They underlie an extensive tract, and are the result of slow evaporation, during geologic ages, of saline lakes. The stratum of carnollite, supplying most of the salts entering into commerce, is from 50 to 130 feet in thickness. It is reached

by ordinary mine shafts, having a depth of from 1,200 to 3,500 feet.

The crude material, mined by customary methods, and brought to the surface, is refined by processes of leaching and crystallization, not unlike those employed in concentrating Chile saltpeter, in the land of its occurrence. Various well-known commercial grades, consisting of chloride or sulphate of potash, or mixtures of the two, with variable amounts of magnesium salts, and containing from 20 to 62 per cent of actual potash, K_2O, are thus prepared.

The mining and purification of these potash salts of Stassfurt, begun in 1861, has become a great national industry. There are now 115 mines. The operating companies are closely united in a combination for selling purposes, which has a control bureau and 510 officers. The mines themselves give occupation to 2,200 officers and 35,000 laborers. The average daily output of crude salts is about 40,400 short tons. The annual output in 1911 was 10,700,000 short tons. About 40 per cent was used directly for fertilizing purposes, chiefly in Germany. The remainder was submitted to refining processes.

The transportation of the general share of this great output, purchased by the United States, would require the services of about 260 steamers of 4,000 tons each.

The fleet is now lying idle, and there is a potash famine in our country.

American Sources of Potash

Let us take an inventory of our domestic resources.

First, there is a vast amount of potash in the refuse from the harvested crops. On an average, 80 pounds are removed annually to each acre under cultivation. Some part of this is found in the grain, tubers, lint, etc., which leave a farm. A much larger part is contained in the straw, stalks, hay, vines, etc., which are apt to remain on a farm, and be consumed by domestic animals. Thus a bale of cotton (500 pounds) contains 2 pounds of potash. The cotton seed, separated from it, contains 12 pounds. The 2,000 pounds of stalks, on which it grew, contain 37 pounds. Again, 20 bushels of wheat contain 6 pounds of potash. The 1,500 pounds of straw, accompanying it, contain 17 pounds. The dried excreta of domestic animals, fed on these crop residues, contain 2.25 per cent of potash. It is evident that by a rigid practice of feeding all crop residues to animals, and carefully conserving the manure, or else by incorporating the residues in the soil, a notable saving can be effected. Tobacco stems from Kentucky contain 8 per cent of potash—an extreme instance.

Wood ashes are in some sections still abundant. Hard wood ashes contain from 18 to 46 per cent of potash. The ashes of conifers contain from 14 to 20 per cent. There is an opportunity for widespread care in avoiding waste in this connection.

The potash of the cane and of the beet root is largely concentrated in the molasses of the sugar refineries. Some 26 distilleries make use of this molasses. The daily loss of potash in their waste is 106 tons. Methods have been recently devised to rescue this amount in a form available for use as a fertilizer.

There are several sources of the alkali among non-cultivated growth. Thus pine straw contains from 0.21 to 0.41 per cent of potash. Marsh grass contains from 0.84 to 2.39 per cent.

The most important of these plant sources, provided by nature, is found in seaweed. The marine growths of the Pacific are much richer in potash than those of the Atlantic. Along our Pacific littoral, including the coast and islands of Alaska, an annual crop of kelp awaits harvesting, containing potash valued at $90,000,000. No plowing, or seeding, or cultivation is required. The bountiful gift of Nature awaits the harvester. Dried and ground, it presents a fertilizer containing, on an average, 19 per cent of pure potash. It can be cut, collected, dried, ground, and transported to South Atlantic ports, at a cost per ton several dollars below the ante bellum rate for Stassfurt salts, equally rich in potash. When used in this form, there is sufficient combined nitrogen

present to increase the value of the annual crop by $60,000,000.

Turning now to mineral sources, we find several lakes in California containing such large amounts of potash, that it is quite feasible to use their brine and sediment as materials for the extraction of potassium sulphate and other salts of the metal.

A much more important source is in the alunite of Utah, Colorado, and Nevada. The mineral, a double sulphate of potash and alumina, is roasted in order to drive off the sulphur trioxide combined with the alumina. From the residue, potassium sulphate is easily extracted by water, and the resultant solution is evaporated to dryness. The deposits at Marysvale, Utah, are ample enough to supply all of the potash required by this country for a century to come. The exploitation of these deposits, on a fairly large scale, has already begun.

The many veins of feldspar, with potash content ranging sometimes as high as 15 per cent, constitute a vast reserve of the alkali, awaiting an economical process of extraction. Quite a group of chemists are actively engaged upon the problem. Chemically, it has been solved. Capital is still hesitant about investing heavily in any of the dozen promising methods, worked out on a scale beyond simple laboratory experimentation

Can We Have an Independent American Potash Industry?

At present the prices for German potash salts in our trade centers are purely nominal. Rates per ton of $400 to $500 are quoted, but there is practically no stock of the salts available. The price for the most common form, the muriate, or chloride, containing 80 per cent of the pure salt (equivalent to 52.7 per cent of K_2O), was $38, per long ton, in July, 1914.

There seems to be no question but that potash, especially in the form of a fertilizer, can be easily supplied from American sources in competition with this rate.

Despite the urgent appeals of consumers of potash compounds, especially in the arts, for supplies at almost any price, there is evidently much delay about taking vigorous, energetic measures to build up a genuine national industry A certain amount of activity is in evidence, in the working on a systematic basis, of the alunite deposits of Utah. Small quantities are regularly obtained at Owen's Lake, California. There are, also, a number of efforts on a very small scale, in Southern California, and about Seattle, to build up the kelp industry. And yet it all is so sadly out of proportion to the nation's needs!

There are several marked difficulties in the way of a healthful evolution of the American industry.

The alunite industry of Utah struggles with the handicap of heavy freight rates across the continent.

The kelp industry of the Pacific Coast is restricted by the lack of legislation, clearly defining ownership in the floating harvest within the 3-mile limit, and safeguarding the establishment of the requisite plant to gather, dry, and market the valuable crop.

In addition to these very pronounced obstacles, there is the inevitable dread, if not certainty, that no matter what rates may be fixed for the sale of American potash in our domestic market, the foreign competitor, on the return of normal international exchanges, will deliberately and persistently reduce the selling prices of the Stassfurt products when brought to our ports, so as to completely throttle any attempt at disputing the hitherto dominating factor in the situation.

There is, therefore, room for enlightened and farsighted legislation, state and federal, to remove absolutely the obstacles in the way of the domestic exploitation of our unlimited potash resources.

There would seem to be, also, a manifest opportunity for intelligent, patriotic controllers of capital, to promptly and decisively settle, on an adequate scale, all questions regarding the cost of production of potash compounds from the different sources enumerated above. There seems to be little doubt but that the dried kelp of the Pacific will eventually be our cheapest form of potash fertilizer. It is a moot question from what source we can most economically secure the technically pure potassium salts required in the arts.

Side by side with a genuinely American solution of the complex dyestuff problem, should stand an equally national solution of the potash problem.

The hardships, incident to the present famine, must be promptly alleviated. The economic fabric of American industrial life must never again be exposed to such loss, such dislocation, through dependence upon a foreign source for the nation's potash supply!

Naval Militia and Preparedness

(Concluded from page 139)

tended to promote good fellowship within the unit and between the various units. Entertainments, dances, smokers, athletic events and other diversions are encouraged with this end in view.

Each division of the Naval Militia must fulfill certain specified requirements imposed both by the various states and by the Navy Department before it is granted recognition. In the first place, comes the minimum number of officers and enlisted men, next comes the performance of the required percentage of drill duty, and then the qualification of a specified percentage with small arms—rifles and pistols; next, the qualification of two crews from each division on the secondary battery—6-inch and under—and, finally, a specified percentage of performance on ordered duty such as battalion reviews and musters and on the annual Federal cruise aboard a battleship.

The regular drill season begins on the first Monday of each November and ends on the last Saturday of May. Under ordinary circumstances there is one battalion drill during each month. The battleship cruise lasts fifteen days. During the summer, small week-end cruises are made on the vessels allotted to the various states by the Navy Department. These cruises are voluntary on the part of the men and, although regular discipline and routine are maintained, they are very enjoyable trips.

It is only fair to assume that the average American citizen is patriotic. As he is recognized to be intelligent, it is to be assumed also that he has drawn conclusions from the examples furnished by the war raging at present in Europe, and such conclusions must point to the fact that some move should be made by the United States toward preparedness not *for* war, but *against* war. Now, as a suggestion to the normal American: Why is it necessary to wait for Congress to mull over the situation and finally settle it with an eye on the internal political result? Let each patriotic man prepare himself to the best of his ability to serve his country in the manner that will make his services most valuable to his country. If he has a profession, let him place himself at the disposal of the nearest National Guard or Naval Militia organization having use for his particular profession, in order that his knowledge and experience may be utilized in the training and instructing of others, while he himself is being trained. If he has a trade, let him enlist in the organization making use of that trade, so that his services may be given the maximum value with the minimum amount of training. If each American does his part in this manner, Congress will be relieved of much of the trouble it is apparently finding, and adequate preparedness will be the result.

New Developments in Military Aeroplanes

(Concluded from page 147)

In addition to this standard type there has been developed in Germany another type of aeroplane-destroyer, which, however, is only placed into the hands of a few very skillful pilots. This machine, of which much has been heard lately, is the Fokker monoplane. In general appearance as well as for its armament the Fokker is a very close copy of the Morane destroyer—even to the extent of its engine, which on the standard type is a 100 horse-power Oberursel-Stahlherz,

the German copy of the Gnome rotary. There is also a higher powered model fitted with a 165 horse-power Mercèdès engine which furnishes a speed of more than 100 miles per hour. Just like the Morane, the Fokker's machine gun fires through the armored blades of the airscrew; and just like its French antagonist, the Fokker embodies climbing ability and "controlled instability," *i. e.*, quick responsiveness to the controls, to the highest degree. This is why only exceedingly capable airmen are able to handle it.

According to recent press accounts of this new German aircraft, the favorite method of attack is for a Fokker to get up high, to about 1,500 feet or so, and fly about until one of the Allies' machines appears in sight below. Then, if of the fixed-gun type, the Fokker stands on its head and dives straight for its victim, loosing off a stream of bullets as soon as it gets within range. By making the descent ever so slightly spiral, the straight stream of bullets becomes a cone of fire, with its apex at the gun, and with the victim inside, so that whichever way the lower machine tries to escape it must pass through that cone. When the Fokker gets close to the enemy, if he be not already hit, it approaches directly from behind, firing straight along the body or fusilage, so as to have pilot, passenger, tanks, and engine all in one line of fire, and unless the pursued machine is very quick on its controls and is able to dodge like a rabbit, some vital part is bound to be hit sooner or later.

Fokkers which do not fire through the propellers almost always attack their victims from behind, diving under their tails and coming up in such a position that, while they can shoot up into the body of the pursued machine, the passenger in that machine, even if sitting behind the pilot, cannot shoot at the Fokker for fear of blowing his own tail off.

The Fokkers have scored notable success on the Western front by destroying 16 British aeroplanes within a month; but they have been much less successful against the *avions-canon* and the aeroplane destroyers of the French. Thus on January 10 an aerial battle was fought above Dixmude between three Fokkers and three *avions-canon*, which resulted in two of the Fokkers being shelled to pieces, while one *avion-canon* was forced to land on account of a pierced petrol tank.

On their part the British have just placed in commission a limited number of novel aeroplane destroyers which have proven a good match for the Fokkers. Thus on January 17th a British airman attacked three Fokkers single handed and forced them to land. On the same day three more Fokkers were put to flight by British pilots.

After all that has been said it must not be forgotten that the Fokker—just like the Morane—is more of a freak than a real fighting instrument; whereas, in order to furnish great speed and climbing ability, it has to carry a very light load, the Fokker's range is limited to a maximum of about two hours' flight. Therefore it cannot be employed for long range operations.

The Germans realize this perfectly well, and that is why they are busily engaged in further developing a battle aeroplane of the type of the famous "Arminius."

The latest reports from abroad state that the French government has cognizance of the existence of a huge German battle aeroplane that was tested with great secrecy on Lake Constance last November. This new machine is propelled by two 225 h.p. and two 130 h.p. engines, probably of the Mercèdès make. This powerplant of over 700-horse-power is said to furnish a top speed of 110 miles per hour. The armament consists of a battery of four Maxim guns and bomb-throwers which are mounted on an iron-clad nacelle. The normal crew consists of eight men. The machine is also equipped with a wireless outfit and a searchlight.

It is further known that the French government is conducting extensive ex-

periments with different types of multiple engined aeroplanes.

The first one of this type, the twin-tractor Caudron biplane, which is fitted with two 80 h.p. Le Rhône engines, is already in commission. This machine carries a wireless outfit and is exclusively used for artillery observation. Its armament is entirely protective and consists of a machine gun mounted on the bow of the nacelle.

The latest aeroplanes, however, will be four-engined with the power plant ranging from 600 to 800 h.p. But the disclosure of further details seems inadvisable for the present.

NEW BOOKS, ETC.

NEURASTHENIA; OR, NERVOUS EXHAUSTION. By J. H. Kellogg, M.D., LL.D. Battle Creek, Michigan: Good Health Publishing Co., 1915. 8vo.; 339 pp.; illustrated. Price, $1.

COLON HYGIENE. By J. H. Kellogg, M.D., LL.D. Battle Creek: Michigan: Good Health Publishing Co., 1915. 8vo.; 393 pp.; illustrated.

Dr. Kellogg has given us in these engaging works so illuminating a survey of auto intoxication, and so sensible a regime for combating this alarming prevalent condition, that every sufferer should avail himself of the experienced aid here extended. In "Neurasthenia" the reader is made acquainted with almost every available means of relief. A noteworthy chapter is that on "Habit, How Formed and Reformed"; in this chapter that microscopic mechanism, the synapse, is explained in its relation to nerve action and habit formation. In Dr. Kellogg's second volume, "Colon Hygiene," the author takes a physiological survey of the field, treats of constipation and toxemia and, in his usual straightforward manner, details the modern methods of "natural" correction. Posture, diet, bathing, exercise, massage, electricity, all are considered in their remedial aspects. The problem of changing the intestinal flora is seriously discussed, and many practical suggestions are offered.

PROJECTIVE ORNAMENT. By Claude Bragdon. Rochester, N. Y. The Manas Press, 1915. 8vo.; 79 pp.; illustrated. Price, $1.50.

We have, Mr. Bragdon thinks, urgent need of a new form language, and this he seeks to discover in four-dimensional geometry. His substitution of angles for curves in ornamental iron-work, and the extreme closeness of his design, will hardly be accepted by modern eyes as pleasing; his mural patterns are so enormous as to dwarf into insignificance the human figure, and it is noteworthy that most of his settings require the Greek costume; modern dress would at once accentuate the fact that accepted modes could never blend with such ornamentation. Perhaps the chief criticism of his four-dimensional method is that, while the spur to originality that, in the brain of some means employed may be new, the resultant symbols or approximate forms have been used for ages. Yet the suggestion of the volume is interesting, and may conceivably serve as a genius, may flower into happy results. What the world most needs, however, is a return to the old purity of principle; this alone can assure designs of taste and distinction.

A VOYAGE IN SPACE. By H. H. Turner, D.Sc., D.C.L., F.R.S. London: Society for Promoting Christian Knowledge, 1915. 8vo.; 394 pp.; 130 illustrations. Price, 6s. net.

Every year, at Christmas time, the Royal Institution has a course of children's lectures, when some well-known teacher or scientist graphically sets before his excited audience the most interesting facts and experiments. In 1913 our author, who is Savilian Professor of Astronomy in the University of Oxford, delivered these lectures, and here we have them substantially as they were taken down in shorthand. In this fascinating voyage through space, our navigator points out the leading figures and discoveries in astronomical history. The work will edify and stimulate any thoughtful boy or girl. Two children have themselves taken a hand in the illustration of the volume, and the result, while it does not reveal any wonderful mastery of technique, speaks eloquently for the inventiveness and imagery of the child mind.

THE TELEPHONE AND TELEPHONE EXCHANGES. Their Invention and Development. By J. E. Kingsbury, M.I.E.E. New York: Longmans, Green and Co., 1915. 8vo.; 558 pp.; illustrated. Price, $4 net.

Mr. Kingsbury modestly refrains from regarding his volume as a full-fledged history of telephony. It would be injustice on our part, however, to deny him the word. The work is indeed not exhaustive, but the selections and summaries have been so wisely undertaken that the general effect is that of comprehensiveness. The author's method has been to select the principal inventions of both the initiatory and development periods of telephony; but, as he remarks, "technical, commercial, and political threads compose the fabric, and they are interwoven in the record." By the narration of prior causes, technical features become easily understandable. Under the caption, "Early Exchange Systems," we find an illuminating survey of the earlier practice; the illustrations are confined for the most part to the equipment of this period, since the modern central office is easy of access to the student. The chapters on "Rates" and "The Economics of the Telephone" noticeably contribute to the value of the work, which is on the whole an excellently balanced discussion in which all inventors are given a free field and no favor.

AUTOMOBILE REPAIRING MADE EASY. By Victor Pagé, M.E. New York: The Norman W. Henley Publishing Company, 1916. 8vo.; 1060 pp.; 1000 specially made engravings. Price, $3 net.

In an exposition much more thorough than that of the handbooks usually found upon this subject, the author gives the motorist and repair man the most approved methods of car restoration. The workshop is planned and equipped, and overhauling and repairing in all their branches are simply explained. This instruction relates not only to the engine and its accessories, but also the chassis and its furnishings. The mechanic will find numerous tables, short cuts in figuring, and rules of practice. Valve and magneto timing, "tuning" the engine, trouble location, and electric starting and lighting are all included. As a work of ready reference this should prove alike valuable to the amateur tinkerer and the experienced workman. Its exhaustive index means the satisfaction of knowing that any desired information may be tapped without a long and wearisome search.

ARITHMETIC OF ELECTRICITY. By T. O'Conor Sloane, A.M., E.M., Ph.D. New York: The Norman W. Henley Publishing Company, 1916. 12mo.; 160 pp. Price, $1.

The twenty-first edition of this popular treatise reduces electrical calculations of all kinds to a series of simple rules which deal only in the terms of common arithmetic. Practical problems and detailed solutions follow each rule. The work will continue to make a strong appeal to students of electricity who are unfamiliar with algebraical methods.

DINOSAURS. With Special Reference to the American Museum Collections. By W. D. Matthew, Curator of Vertebrate Palaeontology. New York: American Museum of Natural History, 1915.

"Dinosaurs" is a monograph in paper covers, which reprints from the American Museum Journal and other sources many popular descriptions by authorities. These are so combined and supplemented as to make a coherent report of the collections in the Museum. The first discoveries of dinosaurs in the Western formations are narrated by Prof. Williston of Chicago University. There are many good photographs of specimens, and restorations are offered by a competent artist working under the supervision of Prof. Osborn. Field experiences form a most interesting part of the treatise, and there is a brief guide to the literature of the subject.

MINERALS AND ROCKS. By William Shirley Bayley, Ph.D., Professor of Geology in the University of Illinois. New York: D. Appleton and Company, 1915. 8vo.; 227 pp.; illustrated. Price, $2 net.

Students of geology who desire to familiarize themselves with the material of the earth's crust without venturing upon extended courses in mineralogy and lithology will find a useful companion in this short, descriptive laboratory guide. Only the most important minerals are chosen, and just sufficient description is given for the identification of each. Within the somewhat narrow limits of its scope, the volume carries out its promise in a well-arranged and helpful text.

SAFETY IN THE FOUNDRY. By Magnus W. Alexander, of The General Electric Co., Chairman Committee on Safety and Sanitation of the National Founders' Association. Chicago, Ill.: National Founders' Association, 1915. 8vo.; 187 pp.; illustrated.

In this work is incorporated the findings of the Committee on Safety and Sanitation appointed by the National Founders' Association. This material is brought down to date, and is augmented by chapters from other sources and by hitherto unpublished illustrations. The foundry yards and floors, with all their machinery and implements, are subjected to a close scrutiny, and the most approved safety methods and devices are placed at the disposal of the reader. There is also a chapter on the physical examination of employes—a commendable addition, since bodily fitness constitutes an even greater assurance of safety than a painted warning sign or a wire screen guard. Foundry managers will find that the work reflects the mature experience of the practical foundryman and executive.

EXPERIMENTAL PHYSICS. A Text-Book of Mechanics, Heat, Sound and Light. By Harold A. Wilson, M.A., D.Sc., F.R.S. New York: G. P. Putnam's Sons, 1915. 8vo.; 405 pp.; illustrated.

Prof. Wilson, formerly Fellow of Trinity College, Cambridge, and now Professor of Physics in the Rice Institute, Houston, Texas, has compiled this text-book to be used in connection with a course of experimental lectures. It is intended for a first year college course, but no previous knowledge of physics is assumed. The author has exercised his selective judgment to good effect, and has included only the fundamentally important things.

Notes and Queries.

Kindly keep your queries on separate sheets of paper when corresponding about such matters as patents, subscriptions, books, etc. This will greatly facilitate answering your questions, as in many cases they have to be referred to experts. The full name and address should be given on every sheet. No attention will be paid to unsigned queries. Full hints to correspondents are printed from time to time and will be mailed on request.

(14033) W. E. H. asks: Will you kindly state in your paper the scientific explanation of the reason why a tin can, whose specific gravity is between 7 and 8 will float. In order to float it must displace a volume of water whose weight equals its own weight, but why does it displace this amount? 2. Is there any unit for momentum in the English system? Is it merely a comparative quantity? A. 1. A tin can containing only air weighs much less than the same volume of water weighs. If the can holds a quart of water, the volume of water will weigh about two pounds, while the iron can will weigh perhaps 4 ounces. If such a closed can is put into a basin of water, its weight, 4 ounces, will push down into the water till it has pushed 4 ounces of water to one side. It then rides upon the water. The water pushes it up or bears its weight, and it floats for the same reason that a board floats, or a man floats. It weighs less than the same volume of water weighs. You ask why does a floating body displace a weight of water equal to its own weight. We have answered it by saying that the body pushes water aside as it settles into water till it has pushed with its whole weight down into the water. If its weight is less than that of the equal volume of water, then it floats. If its weight is greater than that of the equal volume of water, it can push on after its own volume of water has been pushed aside and go on to the bottom. 2. A unit of momentum can be made in the English measures just as it is in the metric measure by using a unit of mass and of velocity. It is not necessary. Why not consider momentum as the kinetic energy of the body?

(14034) W. F. S. writes: Answering your criticism (13077), regarding my computation that cast iron will "float" at a depth of 33.7 miles, I am well aware that compressibility of water diminishes with increase in pressure, but we do not know what occurs after some 90,000 pounds per sq. inch has been passed.

A manufacturer of high pressure hydraulic machinery ran some tests a few years ago, in which pressures up to 90,000 pounds per sq. inch were used. The results of his tests may be found in the proceedings of The American Society of Mechanical Engineers. However, I do not think he paid much attention to the compressibility of water, except that he noticed it decreased in volume considerably. In my computations I figured in the usual way, as is done with steel and iron in metal structures, that strain and compressibility are directly proportional to the stress.

Professor Goodman gives the following constants as values for the coefficient of elasticity of volume:

Water	140
Cast Iron	6,000
Wrought Iron	8,800
Steel	11,000
Brass	6,400
Copper	10,500
Flint Glass	2,400

Thus, on this basis, steel would sink deepest, wrought iron next, and cast iron next.

This same author gives the following as the weight of materials as commonly used in engineering practice:

Cast Iron	0.26 lb. per cu. in.
Wrought Iron	0.278 " " " "
Steel	0.283 " " " "

I therefore cannot understand why or how you can contend that I am wrong when I say that cast iron is lighter than steel. It is considerably lighter even according to the figures which you publish, namely:

White cast	7.58 to 7.73	sp. gravities
Gray Cast	7.03 to 7.13	
Steel	7.60 to 7.80	

Whether water has a "crushing strength" or not I do not know. Maybe it has. If so, it is reasonable to assume that at, say, 200,000 pounds per sq. inch water "crushes" and diminishes very rapidly in volume. This is true in the case of some solids, such as cotton. Cotton is now used for making gears for use in machinery. It compresses rapidly at first as we all know, but on hardening the compression grows less and less just as in the case of water. Finally, though, a crushing strength is reached where the fibres give way and then it is natural to suppose that the volume decreases more rapidly again. The manufacturers of these gears are careful to keep the compression within the safety limit.

I do not claim that 33.7 miles is the "correct" depth at which cast iron will float, but, so far as I know, it is the only figure that has been arrived at as the "probable depth," using our ordinary structural or engineering formulae and a method that is at least fairly rational.

I can see no reason why water may not be compressed until it becomes heavier than

cast iron or steel, even at the rate of diminution of volume as published in the SCIENTIFIC AMERICAN. It is an interesting topic.

We publish in full the reply of our esteemed correspondent, leaving the matter with our readers. We can see no reason from the physical constitution of water to suppose that it can ever become more than 7 times denser than it has ever been made by compression. Nor can we endorse the opinion held by our correspondent that water can have a "crushing strength." Still these are only opinions, and we may agree to differ cordially upon the matter. Neither can prove the other wrong.

(14035) V. L. S. asks: Given the magnifying power and focal length of a telescope and the actual distance of a given object, is there a formula by which to compute the apparent distance of the object as viewed through the lens? If so, what is it? A. The apparent distance of an object as seen through a telescope is found by dividing the actual distance by the magnifying power of the telescope. Thus the moon, whose actual distance is about 240,000 miles, with a magnifying power of 600, is brought to an apparent distance of 400 miles and is seen as it would appear at that distance.

(14036) A. C. asks: Do you know of a formula for a photographic gelatine printing out emulsion, or can you refer me to some literature dealing with photographic gelatine-emulsions? A. You will find formulas for all the various photographic processes, including printing out papers, in our Cyclopedia of Formulas, which we send for $5.00 by mail postpaid. The book contains 15,000 formulas covering every field of work and interest. For a description and table of its contents, see circular.

(14037) E. B. B. writes: Under the head of Notes and Queries, No. 13088 in the issue for Oct. 2, referring to the mode of placing a switch on a board, you say, "The usual and best practice is to have the current enter at the top so that the *blades* will be alive and the *jaws* dead when the switch is open. This is because the blades present more surface and reach out farther than the jaws, so that there is more risk of accident with the blades alive." Evidently you have the underlined words, *blades* and *jaws* interchanged, which gives just the opposite meaning to that which is intended, as explained in the following sentence. A. The accidental exchange of the words "blades" and "jaws" in the answer to query to which you call our attention is obvious. The last sentence is correct, and contradicts the preceding statement. We thank you for calling attention to it.

(14038) E. P. S. asks: In a lecture in the lyceum course at Dinuba, Cal., last winter a lecturer illustrating the phenomena of the gyroscope declared that there is no known explanation of the gyroscopic resistance, and that there is waiting a very large prize for the fortunate discoverer, etc. Will you kindly inform me if it is true that there has been no explanation of the resistance of the gyroscope to the side pressure? If so, is it a fact that there is a prize for the discovery of same? A. We can furnish you with two books upon the Gyroscope, which seem to us to cover the theory of the action of this instrument very well. They are Crabtree's Spinning Tops and Gyroscopic Action, price $2.25, and Cordeiro's Gyroscope, price $1.50. You should read both books. We are not aware of any prize for a theory of the gyroscope. The theory is mathematical and has been quite fully worked out.

(14039) P. C. asks: Will you be so kind as to give me a little information in regards to the magnet on a common magneto used for automobile ignition? Will you kindly inform me how to re-charge the magnet, either by direct or alternating current, so as to put the magneto in good order? A. A magnet cannot be charged by an alternating current of electricity. A direct current is necessary for this purpose. The central station of the lighting service in your place may have the means for re-charging magnets. If so, the best way is to get it done there. If this is not possible, a battery of six or more cells with a strong electromagnet will do the work. The electromagnet should be U-shaped for best results. Place the poles of the magnet to be charged in contact with the poles of the electromagnet, and turn the current on and off for a minute or so. If you wish a certain pole to be positive, you must place this pole in contact with the negative pole of the electromagnet. Usually in a magneto it does not matter which pole is plus, only all the poles of the same name must be turned in the same direction. If the electromagnet is straight and not U-shaped, draw one pole of the magnet to be charged across one pole of the electromagnet, and the other pole across the opposite pole some ten times each, and the magnet will be charged.

(14040) J. W. P asks: I am interested in the making of dry batteries, and would like to get hold of a process to make dry batteries which will give a good current, and which at the same time would not readily deteriorate. Could a dry battery be made which would have the lasting qualities of a gravity battery, do you think; and where could I find a formula for the filling of the battery? If any such has been published in the SCIENTIFIC AMERICAN, kindly give me the date of same, and oblige. A. A formula for filling dry cells which we consider a good one is given in the SCI. AM. Vol. 113, No. 7, page 137, which we will send for ten cents. We fear your condition that the dry cell shall be one which will not readily deteriorate and cannot be fully met. No dry cell has the lasting qualities of a gravity cell, or a wet LeClanche cell.

(14041) G. L. M. asks: What was the nature of the arc employed in generating the high frequency oscillations for the wireless telephone tests between Arlington, Va., and San Francisco, Cal.? A. Thus far the telephone company which undertook the tests has not divulged any technical details concerning the apparatus used in the record-breaking radio telephone transmission. However, it is generally understood that no arc was used but instead there were employed some 300 vacuum high-frequency generator tubes connected to a 250-volt direct current circuit. The primary energy was 300 kw., while the total energy transformed into high frequency current and delivered into the antenna was about 70 kw. at 150 amperes.

(14042) F. J. G. asks: Does a person have to secure a government license to operate a receiving set? What are the laws applying to receiving messages? A. A person does not have to take out a license for operating a receiving set only. However, while all messages may be received, a person is not permitted to divulge to any one else the contents of messages intended particularly for another person. For instance: There are stations sending out press matter to ships at sea equipped with apparatus of the company controlling the station. The press messages are preceded by a statement to the effect that the press matter to follow is intended for ships equipped with certain apparatus. Accordingly, while any one can receive this press matter, they are not allowed to divulge it since that would be taking advantage of a service that has not been paid for. The justice of such legislation is evident.

(14043) D. W. W. asks: Would it be satisfactory to employ a lightning arrester of the type used in telegraph and telephone work for protecting a wireless station against lightning? A. No; such a lightning arrester would not be satisfactory since if it were permanently connected to the aerial the current from the transmitter would jump through the arrester to the ground and thus expend itself without covering the transmitting range desired. There is only one approved method of protecting a station against lightning and that consists of entirely disconnecting the apparatus from the aerial and then grounding the aerial through a heavy switch and ground lead. The switch had better be one of at least 100 amperes capacity and designed for 250 volts. It can be of the single-pole double-throw type so that when thrown in one position it connects the aerial to the station apparatus, while in the other position it connects the aerial directly to the ground. The ground lead should be at least a No. 4 copper wire or a plurality of copper wires of a total carrying capacity equivalent to a single No. 4 wire. This wire should run as straight as possible, entirely outdoors, and devoid of any sharp turns. The ground connection should be as good as is obtainable. When a system of this kind is employed, the aerial should be grounded upon the approach of an electrical storm. In fact, it should be grounded at all times when the station is not in operation. Not only does this method offer the best protection known against lightning, but it also meets with the approval of the Fire Underwriters.

(14044) W. R. D. asks: What does the law specify in regard to the wave length of commercial stations? A. The law is so simple to understand in this case that it may be quoted verbatim: "First. Every station shall be required to designate a certain definite wave length as the normal sending and receiving wave length of the station. This wave length shall not exceed six hundred meters or it shall exceed one thousand six hundred meters. (The wave lengths between these two limits are reserved for government stations). Every coastal station open to general public service shall at all times be ready to receive messages of such wave lengths as are required by the Berlin convention. Every ship station and every coast station open to general public service shall be prepared to use two sending wave lengths, one of three hundred meters and one of six hundred meters, as required by the international convention in force: Provided, That the Secretary of Commerce may, in his discretion, change the limit of wave length reservation made by regulations first and second to accord with any international agreement to which the United States is a party. Second. In addition to the normal sending wave length of all stations, except as provided hereinafter in these regulations, a station may use other sending wave lengths: Provided, That they do not exceed six hundred meters or that they do exceed one thousand six hundred meters: Provided further, That the character of the waves emitted conforms to the requirements of regulations third and fourth following. Third. At all stations if the sending apparatus, to be referred to hereinafter as the "transmitter," is of such a character that the energy is radiated in two or more wave lengths, more or less sharply defined, as indicated by a sensitive wave meter, the energy in no one of the lesser waves shall exceed ten per centum of that in the greatest. Fourth. At all stations the logarithmic decrement per complete oscillation in the wave trains emitted by the transmitter shall not exceed two-tenths, except when sending distress signals or signals and messages relating thereto.